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The Hedgehog Transformer. SOME details of the practical form of the so-called "hedgehog" transformer will be found in another column. On no subject is English and American engineering practice more at variance than in the methods and apparatus of alternating stations. If the figures for transformer efficiency obtained at Cornell University this year should be verified, it would seem as if we had little left to desire in the direction of design. Apparently, the usual practical figures are not so high as those given in the paper mentioned, so that after all Mr. Swinburne's device may have some good reason for existence. It seems to us, however, that the most effective way to secure a high all-around efficiency is to arrange the system of distribution so as to obtain a high average load. Free running in parallel and rather larger transformer units would probably decrease the average losses of alternating current distribution very perceptibly.

The Assembled Telephonists. THE National Telephone Convention in Detroit the present week is a manifestation of the excellent results that can be obtained by intelligent combination. Never a meeting passes without material additions to our knowledge of the conditions arising in telephone service, and to the probabilities of immediate improvements. We have much yet to learn concerning the development of telephonic service; much has already been accomplished, especially in the direction of long-distance telephony, that would have seemed impossible a very few years ago, but we naturally look to assemblies like the present for glimpses of what can yet be done. Aside from this scientific side of their work, these conventions do excellent service in guarding the mutual interests of the great organizations there represented, and in producing uniformity of practice and general prosperity.

An Electric Elevated Road. OUR St. Louis correspondent gives a description this week of a form of elevated road that is being exploited in that city. The general plan proposed—a single-rail road—is hardly a novelty at this date, as it has appeared periodically before the public in various guises during some fifteen years. The present form, however, is somewhat simpler than most of its predecessors, and has the advantage of being designed for the use of electric power, thus avoiding the really considerable difficulty of a single-rail locomotive. So far as the alleged saving of power in roads of this type is concerned, we have yet to see either theoretical or practical evidence of its material existence—at least to any useful amount. Nevertheless, the cheapness and lightness of the overhead structure constitutes a great advantage over the elevated tracks now in use, and the single rail construction is all that could be desired in the way of facilitating obtaining charter rights. Experiments in Boston some years ago showed conclusively that very sharp curves and severe grades are within the powers of this kind of road, but in spite of these excellent qualities the various plans proposed have made very little practical headway. Possibly the use of electric power may improve the chances of this latest comer, for there were serious objections to a locomotive running on but a single rail that do not exist in the case of the electric motor. We would certainly like to see the St. Louis plan tried on a practical scale, and given an opportunity to show its actual merits.

A Great Western Station. WE present this week a full account of the remarkable station in Spokane Falls, Washington. The accompanying cut gives a clear idea of the arrangements employed. The station is a peculiarly interesting one to electricians from the fact that in it water power is used upon a gigantic scale and under conditions rarely met. The supply of power is greatly in excess of the present needs of the station and the head of water is exceptionally large. As a result we have the singular condition of affairs that the driving turbines run as fast or faster than the driven dynamos, so that the belting is of the most direct kind, and all the intervening losses frequent in stations of nearly every kind are avoided. The dynamos themselves, as will be seen, are in the upper story of the building, and the belts are carried straight from the turbines below. It will be exceedingly interesting to watch the results developed by a station of this character. Heretofore in water power stations the principal disadvantage has been the difficulty of proper regulation, and under the conditions found in Spokane the turbines will be peculiarly sensitive to any momentary change of load on the dynamos, as there are no intervening fly wheels of any kind. The difficulties of regulation once overcome, and we have an almost ideal supply of power. The Spokane station is interesting, however, not only on account of its engineering features, but by reason of the evidence it gives of the tremendous activity of the Pacific Coast in taking up and pushing every improvement that can possibly add to the resources of a singularly active community. Few of us here in the East have any adequate idea of the amount of push and energy that is developing the extreme northwestern portion of our country, and the magnitude of a single electrical industry in a single city, as shown in the description we are discussing, will be a revelation and should be a stimulus to less enterprising sections of the country.

Inductor Velocity in Dynamos. THE able paper of M. Rechniewski, which we publish in this issue, takes up what to most practical electricians will be a rather new phase of dynamo designing. He treats especially the question of the most desirable inductor velocity and its effect on the working efficiency of machines. It is a question quite analogous to that of piston speed in engines, except that the sources of loss in the dynamo introduce new and important features into the problem. M. Rechniewski has investigated with a great deal of care the losses of various kinds that take place in dynamos, and the way in which the dimensions can be varied so as to produce the best results. The experimental research on the amount of cooling in the armature as a function of the speed is particularly instructive; and throughout the paper will be found a great many details of dynamo performance not usually treated in discussions of this and similar subjects. Of course, the practical application of the principles laid down in this paper is limited by various commercial considerations; but there is a large class of dynamos in which high output per unit weight is desirable, and here the propositions laid down by M. Rechniewski are of considerable importance, and a careful study of his figures may point the way to useful results. Like most dynamo designers, M. Rechniewski is fully aware of the advantages presented by multipolar machines for large outputs. Present practice tends toward replacing the very large two-pole machines by the more advantageous form, and especially in motors, as where weight is frequently an important consideration the multipolar construction possesses merits that cannot be overlooked. The efficiency tests found in this paper show that the author has reached practical success as well as theoretical experience, and ought to give added weight to whatever he has to say concerning the theory of electrical machine design.

A Group of Dynamos. MR. WADSWORTH'S paper, published on another page, contains a great deal of very suggestive matter that will repay more than a casual study. Perhaps the most striking feature of the paper is a description of an alternator almost precisely like the Thomson machine described a few weeks since. The principle is identical and the construction even simpler. The mechanical details, however, are decidedly more perfect in the later machine, since its armature can have a considerable end play instead of requiring thrust bearings as in the form described by Mr. Wadsworth. Another very pretty and ingenious conception is the multiple disc machine, an ingenious modification for practical purposes of the theoretical machine designed so long ago by Faraday. The form proposed will unquestionably give a considerable voltage, but its mechanical construction is open to criticism both on account of the vertical armature and the mercury contacts. These latter would probably limit the current to a figure considerably below that derived from the conductivity of the various portions of the armature. Machines of this sort are of great theoretical interest and are worth careful consideration as possible commercial dynamos, even though the forms shown are not thoroughly fitted for practical use. It is not at all unlikely that such exceedingly simple dynamos may eventually find a considerable use. The interior magnet construction proposed by Mr. Wadsworth is excellent, and for certain purposes might prove quite effective in practice. The suggestion for revolving both armature and fields in the motor in opposite directions we may however consider more interesting from the standpoint of a student than that of the practical engineer, as such devices involve the very gearing that everybody wishes out of the way. Although none of the machines described in this paper are striking innovations, they certainly show a great amount of ingenuity and designing skill on the part of the author. They are all singularly clever modifications of well known general types of machine and should prove peculiarly suggestive to the mind that is alert for every possible line of improvement.

The Traction of the Future. No better sign of the times can be found than in the interest shown by the various street railway associations in the use of electricity. At the last meeting of the National association the horse was emphatically in the back ground, and discussion turned not so much upon the advisability of adopting electric power as upon the relative merits of various electrical devices. This autumn the case will be much the same. The coming meeting of the New York State association will be in large measure given over to things electrical, and when the National association meets next month in Buffalo much the same state of things may be expected. Nearly two thousand miles of electric railway in actual operation bear ample witness to the commercial success that has attended the abolition of the horse, and are a sufficient answer to the doubters who denounce electric traction as an ephemeral fad. No report of failure comes from any road that has taken up the electric motor, and the uniform experience of many has shown decreased expenses and immensely increased traffic. By the way, it is somewhat surprising to find one of our technical contemporaries speaking as if the efficiency of the electric street railway was a matter of doubt concerning which there is little or no definite knowledge. On the contrary, the matter has been pretty thoroughly investigated during the past year and a half, and a glance at the half-dozen long articles that have appeared in THE ELECTRICAL WORLD on this subject ought to convince our dubious friend of his error. The results reached by the various independent experimenters have not only shown most remarkable agreement with each other on all essential points, but they have marked out pretty clearly the conditions necessary to efficiency, and the probable line of development. There has been, to be sure, great increase in efficiency in some of the more recent roads, but it is largely due to heeding the admonitions of experiment, and to the knowledge of the very facts the existence of which has been called in question. Whatever may be said of the occasional low efficiencies that come to light, they assuredly are not now due to ignorance of the proper means of improvement.

ELECTRICAL WORLD PORTRAITS.—XVI.

PROFESSOR EDWIN J. HOUSTON.

Few names are more familiar to electricians of the present day than the subject of this sketch, who, from his long connection with educational interests in Philadelphia and his intimate association with the development of electric lighting, has made his reputation thoroughly familiar to every one even casually interested in electrical affairs.

Edwin James Houston was born 46 years ago in Alexandria, Va. He was educated principally in the public schools and graduated from the Central High School of Philadelphia, which institution he has so long ably served as professor. Prof. Houston afterward studied abroad, and for 25 years has been most intimately connected with scientific education. He first taught at Girard College, Philadelphia, and not long afterward was elected professor of civil engineering in the Central High School, only to be transferred a year or two later to the chair of natural philosophy, which he has since occupied.

A little more than 10 years ago, Prof. Houston took up the then new subject of electric lighting, and, in company with Elihu Thomson, then, like himself, a teacher in the Philadelphia public schools, elaborated the Thomson-Houston system which has since made its way into prominence all over the civilized world. Of the splendid work accomplished during this scientific partnership, there is little need to tell. It is part of the history of modern electricity. He is one of the pioneers in electric lighting in this country, and his numerous inventions have met well-deserved success. In 1884 Prof. Houston was appointed by the United States government a member of the United States Electrical Commission which convened in Philadelphia, and was also elected by the Franklin Institute chief engineer of the International Electrical Exhibition. A very large amount of interesting scientific work was accomplished at this time, and the exhibition was well carried out and was singularly successful. The practical tests of electrical apparatus made at this time were of unusual value, and form a most valuable contribution to technical literature.

Since that time Prof. Houston has been most prominent in electrical research and investigation of every sort, and has devoted no little time toward the popular exposition of the science in which he has received so enviable a reputation. He is officially connected with a considerable number of societies. He is professor of psysical geography and natural philosophy in the Central High School of Philadelphia and professor of physics in the Franklin Institute, and is one of the editors of the *Journal of the Franklin Institute*, besides being a member of the American Philosophical Society, the American Institute of Electrical Engineers, the Franklin Institute, the American Society for Psychical Research and other learned bodies.

His contributions to the literature of natural science have been numerous, and a considerable number of meritorious books have been turned from his ready pen. Among them may be mentioned: "Elements of Natural Philosophy," "Elements of Chemistry," the interesting series of "Primers of Electricity," "The Telephone," "Electrical Furnaces," and more especially his recent and valuable "Dictionary of Electrical Words, Terms and Phrases," which has already found its way into the libraries of a very large proportion of electricians. This work is now undergoing a most elaborate expansion and revision at the hands of its accomplished author, in preparation for a new edition. This list does not include several brief text books on scientific subjects. Prof. Houston is a frequent contributor to many current scientific periodicals, more especially to the *Journal of the Franklin Institute*. A few of his papers here published have been: "Artificial Production of Low Temperatures," "Electrical Determination of the Velocity of Projectiles," "A System of Fac-simile Telegraphy," "Despretz's Artificial Diamonds," a series of articles entitled "Glimpses of the International Electrical Exhibition," "The Allotropic Modification of Phosphorus," "Phenomena of Induction," "Synchronism," and numerous others.

In his long professional career he has given a large amount of attention to public lecturing, and has done admirable service to the advancement of science by his courses of popular lectures. Professor Houston is an indefatigable investigator, and, as can be easily seen from this brief sketch, his contributions to the electrical science of the century have been very valuable. His life thus far has been a singularly useful one, and keeping pace as he does with all the modern advance of the science to which he has so long devoted himself, the coming years bear promise of even greater service to science and to the cause of popular education to which he has devoted so large a portion of his intellectual activity.

Few accomplished electricians in this age of immense commercial developments, are sufficiently awake to the interests of the community in which they live to put aside opportunities for their own material welfare, and to devote their valuable time to instruction. In that field the work is hard, and the rewards, viewed from the worldly standpoint, are small, but the devotion of a single man to the cause of learning leaves an impress on the minds of the coming generation that will make his personality long the subject of grateful remembrance.

Inductive and Earth Interference with Telephone Service.

BY DR. LOUIS BELL.

Until within the last three or four years the telephone service of this country had gone on in its steady course of growth and extension without meeting serious difficulty from interference of extraneous circuits. Of course, the well known phenomena of cross-talk had made it very clear to all telephone men that they were dealing with a remarkably sensitive instrument; but it required the advent of the alternating current and the electric railway to bring electricians to a realizing sense of the conditions that must in the future be contended with. Strange to say, the theory of induction under the conditions met with in telephone service has not received a very large amount of practical attention. The general theory of the subject is, however, comparatively simple, and making the necessary special integrations for the case of parallel lines usually met with in telephone induction, we arrive at results that are to a certain extent discouraging. Although the practical features of the case are already known to many telephone engineers, it may be worth while to restate the matter here. Given a telephone line running parallel to an electric light or power circuit, what will be the resulting induction? Without going through the mathematical inspection of the case, it finally results that the factors entering into the disturbance produced will be the distance between the lines, the length of parallelism, the self-inductions and resistances of the respective circuits, and the period and strength of the disturbing current. The total effect varies directly with the distance through which the circuits are parallel, and inversely with the distance between them. It becomes then unpleasantly evident that the mere fact of distance between lines is not able to reduce the disturbing induction except as the length of wire under induction remains the same. Consequently it is quite possible for very severe induction to take place between lines which nowhere approach each other within several hundred feet, provided the length of parallelism is sufficient. On the other hand, a telephone wire running near a disturbing circuit, even for a very short distance, will be affected in a most marked way. In fact, the amount of induction depends on the ratio between the distance of parallelism and the distance between the lines rather than on the absolute value of either of these.

PROFESSOR EDWIN J. HOUSTON.

This fact is not entirely new, but is one to which comparatively little attention has been paid. A pair of cases from the writer's observation will illustrate the point admirably; both were specimens of pure inductive interference from an electric railway circuit. In the one case the telephone wire ran parallel to the disturbing circuit for about a third of a mile with the full width of a rather wide street between them—75 feet or so. The disturbance produced by the variations in the railway current were exceedingly marked, and almost destroyed the usefulness of the telephone. In the other case the trouble was nearly as great, but the entire interfering portions of the two wires were not more than 100 feet long, running, however, on the same pole about 18 inches apart.

Another case that was brought to the writer's attention was a telephone wire between Chicago and Milwaukee, paralleled a large part of the distance by a telegraph line, on which an automatic transmitter was in use, the intervening distance being more than 100 yards. The result was the disabling of the telephone line. Still another example on a small scale was found in a long distance telephone line that ran nearly parallel to a railway circuit for a length of about 100 feet at a distance of about 3 feet. The result was very marked interference, so that not only the running of the cars, but the whirr of the dynamos at the power station was distinctly heard. These examples are sufficient to show the importance of considering the distance ratio previously mentioned; and if more care were taken in running circuits—as indeed there is in some localities—we should be far less familiar with inductive interference. In a very large number of places it seems to be forgotten by both the interested parties that to avoid trouble the wires must be kept away from each other, and if they were run parallel for any distance must be kept very far away from each other. There is too much tendency to fancy that a power circuit will do no harm because it runs parallel to the telephone lines for only a very little distance. This phase of the subject is dwelt upon to an extent uncalled for, perhaps, by very many readers, but so many cases of really needless interference, produced by ignorance or neglect of these very simple conditions, have come under observation that it seems not out of place to emphasize the facts. It is unnecessary to state to any electrical reader that in the matter of induction very much depends on the frequency of the variations of the inducing current. The cause of the marked effect mentioned above in the case of an automatic telegraph transmitter was in great measure the high frequency of the variations of current experienced on such a line. As the induced current is the same period as the inducing one, a great deal can be learned by locating the various disturbing causes through the pitch of the sounds produced. Some cases of induction recently observed by the writer were rather amusing, in that complaints of disturbed telephone service were very loud shortly after the advent of an electric road, while on listening at the telephone the sounds proved to be produced by an old and familiar electric light circuit, as could be readily told by the pitch and uniformity of the tone produced.

So much for a view of the phenomena concerned. As regards remedy, in the discussions that have taken place on the subject several things have frequently been forgotten. One of these is that a return wire for the inducing current may or may not completely remedy the difficulty. If the two are closely parallel and the currents are in the same phase, there will be no effect on neighboring wires; but if, as is always the case in street railway work, the phase of the disturbance is changed by the interposition of the motors, there is likely to be some residual interference with neighboring wires. In other words, if anything disturbs the balance of the outgoing and returning current, either in quantity or in phase of disturbance, there will be trouble. This is sufficiently exemplified in the case of double trolley railroads where so long as there is no leakage through the car or along the line there is little or no trouble with the telephones; but if there is a ground on the car, even in a position where there would be no direct passage of the current to the grounded telephone wires, the trouble will be nearly as great as on a single trolley line. Only a complete return circuit on telephone wires can avoid every trace of interference.

Although the writer pointed out more than a year ago an arrangement of feed and trolley wires for electric railway work which would give with a single trolley nearly the same immunity from trouble as is ordinarily found with double trolley, unfortunately induction is not the only thing we have to deal with, and some interesting cases have recently come to light of extraordinary difficulty with stray currents in the ground. Perhaps one of the most striking came from London, where the alternating mains of the great Ferranti system produced ground disturbances that caused currents as high as the one-tenth of an ampère on the London telegraph lines, and especially on a circuit that ran from London to Rome, rendering it almost useless.

A similar formidable disturbance was recently observed on the lines of the Commercial Cable Company near New York. This ground interference is something that is comparatively little understood and ought to receive very careful study both from electric power and telephone electricians. It constitutes by far the most formidable part of the difficulty usually met with. Very severe interference with telephone wires, such as drops shutters at the exchange and causes the bells to ring when a car is passing, is almost invariably caused by ground leakage, and can usually be traced to grounds on water or gas pipes that run near to the disturbing conductor. A little care in keeping away from lines that are liable to disturbance would avoid most of the trouble from induction, but that from the ground is very singular in its persistence and erratic ways. We have very little information as to what really becomes of a current after it enters the ground. It certainly appears to stray in a very remarkable manner and without any great regularity of purpose. It would be a great service to practical electricity if all the striking cases of ground interference that come under the notice of telephone managers could be gathered together and used to form some general idea of the conditions in which trouble could be expected, and how far it is possible to avoid it by simple precautions. As it is now the difficulties encountered by telephone managers are very great, and the remedies, aside from a very complete metallic return, have not been altogether satisfactory. It seems highly probable that if a more careful study of the

conditions that follow grounding a variable current were generally made, it might be possible to avoid difficulty with telephone lines from grounds as easily as we now can avoid serious induction by keeping at a reasonable distance, and to secure excellent service without the expense of metallic circuits. The facts in the case have not been collated as yet with the care that the importance of the subject demands, and if this brief discussion of some of the facts involved can stir up sufficient interest in the matter to lead to proper investigation of the very extraordinary behavior of earth currents it will have served its purpose. It is more a plea for the study of the complicated and interesting phenomena met with in these disturbances of telephone service than anything of a more scientific and definite character.

A vast store of information on this subject has been accumulated by independent observers in the course of practical experience; and if it could be gathered and utilized the public would undoubtedly soon have the advantage of lessened trouble with so important a factor in business affairs as the modern telephone system. There ought to be full harmony between the telephone and other electrical interests in this matter of interference. The legal aspects of the question are not in a very satisfactory state, and much more good can be done by a thorough policy of arbitration than has been accomplished by more vigorous means. It is pretty clear that the public will not tolerate destruction of its telephonic facilities, nor will it sacrifice its electric light and power. It is a most unfortunate thing that the interests involved have come into collision so often, and it would be of general benefit if the whole subject could be looked into exhaustively and means taken to secure as amicable an adjustment of existing differences as is possible. If it were quite clearly understood just what interferences may be regarded as preventible by simple means and what are unavoidable or can only be escaped by great trouble and expense the equitable adjustment of the differences now existing between the parties concerned would become very much simpler than it is at present. A thorough study of the phenomena would very much facilitate adjustment of the whole matter, and it is in the hope of stimulating such an investigation by calling attention to some of the conditions to be met, that this brief discussion of the matter has been written.

The Great Central Station at Spokane Falls, Wash.

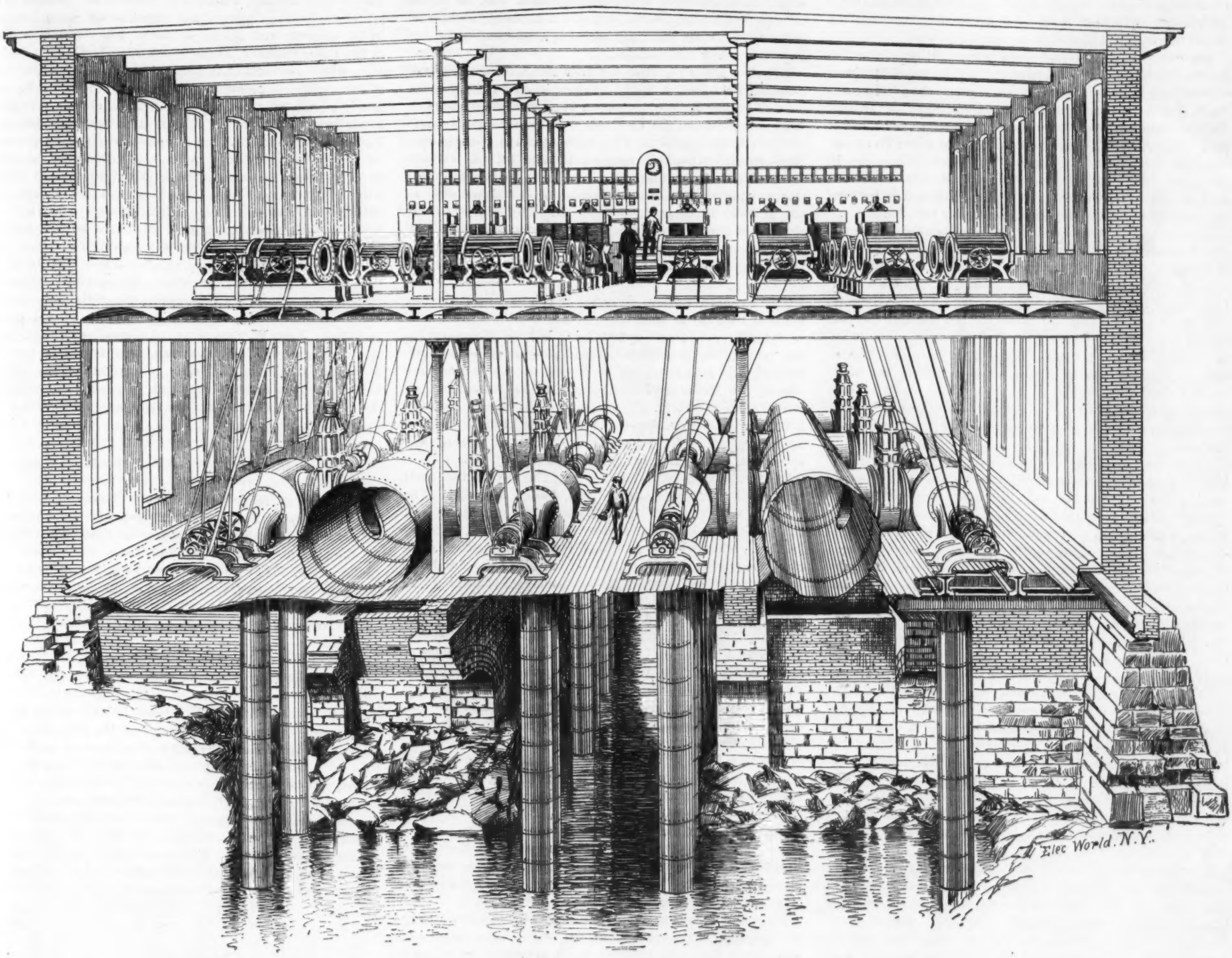
The remarkable electrical developments in the far west are nowhere more strikingly exhibited than at Spokane Falls. The rapid and phenominal growth of this city finds its parallel in the growth of its electrical industries, and this is undoubtedly due in a great measure to the magnificent water power that the city possesses.

Spokane Falls is situated on the falls of the Spokane River, about 30 miles from its source in Lake Cœur d'Alène. When the river reaches the city it is broken up into several channels by masses of basaltic rock, and a series of useful waterfalls are formed within the city limits. The various channels unite just before the lowest fall is reached, and the full volume of the river then makes a final plunge of 70 feet, the total amount of fall of the river from the first of the series to the last being about 130 feet, and developing at its lowest stage at least 30,000 h. p.

Electric light in the city was first supplied by the Spokane Falls Electric Light and Power Company in 1885, the capacity of the plant being 12 arc lights and 300 incandescents. In 1888 the Edison Electric Illuminating Company, of Spokane Falls was incorporated, and acquired possession of the plant of the Spokane Falls Electric Light and Power Company, and increased its capacity to 1,200 incandescent lights and 80 arc lights. In August, 1889, at the time of the great fire, the plant consisted of 135 arcs and 1,800 incandescents. Since then the pole lines have been rebuilt and extended and there have been added 215 arcs and about 3,200 incandescents, bringing the total capacity of the plant up to 350 arcs and 5,000 incandescents. The Edison Company, which controls the entire lighting field, is running its present plant in three separate stations; but the increased demands for light and power, and the outlook for the future have caused it to build and equip a large central station.

This new station is situated at the foot of the lowest fall on the south side of the river, at the corner of Front and Munroe streets, on the property of the Washington Water Power Company. This site was selected by the engineers of the Edison Company as being the best spot for obtaining absolutely trustworthy power all the year round, and where the station could be enlarged to meet the demands of a city of 100,000 people.

The dimensions of the main building are 65 × 120 feet. It is two stories high. The wheel room and foundations are composed of heavy granite rubble, obtained from neighboring quarries, laid in Portland cement mortar, 2,500 perch of granite and 1,000 barrels of cement being used. The upper portion of the building is composed of brick with pilastered walls. One opening 12 feet wide is left on the west face of the granite foundation for the tail water to flow out. The lower part of this foundation will be exposed to the action of high water. The floor girders are of rolled iron, the columns of cast iron, and the floors are of corrugated iron arches covered with Portland cement concrete and tiling, supposed to be absolutely fire-proof, the entire building being designed with this end in view. In an annex to the east end of the building are the storeroom, machine shop, boiler room for heating apparatus etc., and office. On the west end of the roof of the building a cupola is erected to take the wires leading the electricity out of the building. An elevator with a platform 6 × 6 feet, together with two flights of stairs, furnish the necessary communication between the two stories. The main entrance is on the east end of the building.



INTERIOR VIEW OF THE NEW LIGHTING AND POWER STATION AT SPOKANE FALLS, WASH.

The supply of water to run the turbines come down into the station through two steel penstocks, each seven feet in diameter. The upper portion of these penstocks is made of one-quarter inch tank steel, the lower portion where the pressure is greater being made of five-sixteenths-inch steel. The distance to the point where the water is taken from the pond is nearly 500 feet. These penstocks deliver 2,700 h. p., and the volume of discharge passing through them when all the wheels are open is 425 cubic feet per second, the amount of fall being 70 feet.

All the wheels and hydraulic equipment are on the first floor of the station, the second floor being devoted to the dynamos and electrical apparatus, and the wheels belting direct to the dynamos from underneath.

The wheel equipment consists of 12 pairs of Victor turbines of the twin horizontal pattern. Four pairs of these wheels are of 15 inches diameter, and have a capacity to drive 24 Thomson-Houston arc dynamos of 50 lights each. The other eight pairs of wheels are of 10 inches diameter, and have a capacity to drive 16 No. 20 Edison dynamos. Friction clutch pulleys are used on the wheel shaft of the

larger wheels, so that any one of the dynamos can be stopped at any time, should it be necessary, and still leave the others running. These are the invention of Mr. Rice, of the firm of Stilwell & Bierce, Dayton, O., and have in the experience of the company given excellent satisfaction.

The centres of the turbines are located 20 feet above extreme low water, so that there can never be any danger of high water interfering in any way with their running. All the turbines run under a pressure due to 70 feet fall of water, those driving the arc machines making 675 revolutions per minute, and those driving the incandescent machines making an even 1,000 revolutions per minute. In the arc department each pair of wheels has a capacity of 375 h. p. In the incandescent the wheels have a capacity of 175 h. p. each pair.

A large gate is placed in the pipe between the different wheel cases and the main penstock, so that the supply of water to any one set of wheels can be entirely shut off while all the other wheels in the station are running, thus enabling a man to get inside the wheel case should there be any occasion for repairs or the removal of obstructions which may have been brought down by the water into the wheel case.

The principle of driving the dynamos direct from the shaft of the small turbines running at high speed has been successfully tested in one of the company's present stations, this station being operated by one pair of 15-inch Victor turbines, running at 600 revolutions per minute, and driving at full speed with full load three Thomson-Houston 50-light arc dynamos, and two Edison No. 16 dynamos with excellent regulation, and almost without any repairs. This station has run continuously without any stop whatever for a period of over six months.

The designs for the head gates and racks where the water is taken from the dam provide two different ways of shutting off the water from the penstocks, so that in case of accident the water can be shut off quickly to permit of men going inside the penstocks to make repairs. The racks which strain the water before it enters the penstocks are of three-sixteenths-inch flat iron, the spaces between the bars being three-eighths of an inch. It is necessary to have the spaces small, as the wheels are of so small a diameter that the buckets would be easily choked up should pieces of bark or chips of wood or other like foreign matter be carried down with the current into the wheels.

The water power designs have been carried out with the idea of duplicating as nearly as possible the perfection of small units of power as now in vogue in the best constructed Edison stations in the East. For instance, in the Edison department, each pair of wheels drives a pair of Edison dynamos; and as there are eight pairs of wheels driving eight pairs of dynamos, any variation of load, distributed as it would be over the equivalent of 12,000 lights, would be unnoticeable to the consumer. In the arc department, where there is no variation of load to be noticed, the wheels are designed with the idea of carrying six machines each. The early lights run exclusively from one machine and are usually all started and all shut down at the same time. The all-night machines, to the number of six, run from another pair of wheels. This arrangement is carried out in the entire arc department. The duplication of flumes has been found necessary after a long experience with water power and will enable the company to shut down either one of its flumes during the day time without impairing the day service in any way; and, as already stated, any one of the water wheels can be shut off, leaving all the others in full operation.

The station throughout has been designed with the one idea of getting absolutely uninterrupted power both day and night all the year round, and the most experienced engineers that have examined the plans and designs agree that the company, while adopting a somewhat new departure in the development of water power, has succeeded in accomplishing its desideratum.

The plans for this station and the designs for the hydraulic arrangements are the work of Henry A. Herrick, resident engineer of the Washington Water Power Company, under the superintendence of Col. J. T. Fanning, consulting engineer, and give evidence of great skill and care. The turbines, penstocks, and all the wrought and cast iron work used in the construction of the station were furnished under one contract by Messrs. Stilwell & Bierce of Dayton, Ohio, the gross weight of the order amounting to 600,000 pounds.

The accompanying cut gives a perspective view of the interior of the station, showing the main penstocks running parallel to one another, the wheel cases, pulleys, and belting, all on the first floor; and also the arrangement of the dynamos and the electrical gallery at the east end on the second floor.

The electrical plant, consisting of the dynamos, electrical apparatus for regulating and controlling the Edison system, and the switch board and ampère meters for the arc circuits, is located on the second floor of the building. The floor space is so arranged that the plant can be increased, as the demand for light requires, up to a total of 12,000 incandescent lights and 1,200 arc lights, supplied by 16 No. 20 Edison dynamos, and 24 Thomson-Houston 50-light arc dynamos. Fourteen of the Edison dynamos have a normal current capacity of 400 ampères each, but can be loaded considerably over this in case of an emergency, the voltage being kept constant at 140 volts. The remaining two Edison machines are specially built for a normal current capacity of 300 ampères, but they can also be considerably overloaded if necessary; the voltage of these two machines is 185 volts. These dynamos weigh about five tons each, and run at a speed of 700 revolutions. All their bearings are of the self-oiling type, which is now so well known in electric lighting plants all through the country. The arc dynamos are the ordinary pattern Thomson-Houston 50-light machines. They weigh three tons each, and the speed is 820 revolutions.

All the dynamos, both arc and incandescent, are set on raising and lowering devices to enable the tension on the belt to be increased or diminished as desired, and these devices are carefully insulated from any ground connection.

Attached to the roof, over the centre line of each row of dynamos, is a girder running the whole length of the station and equipped with a trolley and hoisting apparatus, so that the armatures of the different dynamos can at any time be readily removed in case renewal becomes necessary. This traveling crane arrangement will be strong enough to lift out an entire dynamo if necessary, while the other dynamos are running, allowing a new one to be put in its place in a few minutes.

The electrical apparatus for indicating, controlling and regulating the Edison lights is arranged on a gallery at the west end of the station, as shown in the accompanying cut. All the cables from the dynamos are brought underneath the floor to this gallery. The cables used are those supplied specially for this purpose by the Edison Machine Works, and the dynamos are so connected to the bus bars that any one dynamo can be thrown on to either side of the system, as desired. This is done by means of the change switch on the headboard of the machine. The positive and negative cables are connected direct to the bus bars, the neutral being taken from the dynamo switch.

The dynamo switch, dynamo regulators and dynamo ampère meters are arranged on either side of the middle of the gallery, a small space being left in the centre for the neutral ampère meter, dynamo galvanometers, etc. Behind this apparatus on each end of the gallery are placed the feeder switches, comparative indicators and feeder ampère meters. The system of indicating pressure is that ordinarily employed in the standard Edison stations. Space is provided for twenty feeders, but at present only about half of this number are being used.

The neutral bus bar is run along at the top of the shelf on which are placed the neutral feeder switches. The positive and negative bus bars are run along the face of the partition. There are two sets of positive and negative bus bars, one set being provided for running at the ordinary pressure, to which are connected all of the 14 dynamos as mentioned above; and a special set of bus bars, to which are connected the two special dynamos. These latter bus bars are used to supply current to the feeders running long distances from the station, on which feeders is allowed a drop of about 40 per cent. A couple of switches are provided to enable any pair of the ordinary dynamos to be thrown on to this special set of bus bars and in this way a pressure intermediate between the ordinary and the special can be carried. A pair of switches are placed in the centre of the gallery to enable these two sets of bus bars to be thrown together; and the feeder switches for the long distance feeders are arranged with double blades so that these feeders can be thrown on to either set of bus bars as desired.

No feeder equalizers are used on the ordinary feeders, but equalizers are provided for the long distance feeders, so that they can be used if necessary. The company expects, however, that they will not be required, as the mains are large and are well cross-connected.

The switch board and ampère meters for the arc circuits are arranged at the east end of the station on a raised gallery, while the wall controllers are arranged down each side. The dynamos are connected to the wall controllers and switch board with flexible cables of Grimshaw white core wire. The positive wires are all taken into a testing room in an annex to the building. In this room all the lamps are adjusted, and it is possible at any time to run a dynamo with a full load and have all the lamps burning in the station.

The wires from both the Edison and arc galleries are taken up and run overhead to a cupola on the roof at the west end of the building. Here are placed the lightning arresters on the arc circuits, the ground wire from the arresters being run outside the building and well grounded in the river.

The overhead system is used for distribution. The poles are 50 feet over all, and are 9 to 10 inches in diameter at the top. They are all straight, sound poles of green cedar, set at the outer edge of the sidewalk, and are painted white with black butts, the cross arms being painted a dark green. Every pole is stepped and bound with flat iron at the bottom to prevent its being cut or damaged in any way.

The incandescent system is built with pole-line safety catches every two blocks, so that any section of main desired can be disconnected in case of fire or for repairs without affecting the rest of the system, and all the arc circuits are provided with absolute cut-out switches placed on the cross arms for the same purpose. The sizes of the mains vary from 80,000 to 280,000 c. m. and wherever possible they are cross connected. The plans and designs for the electrical equipments of this station are the work of John B. Fisken, electrician of the company. It is probably the greatest water-power station for the generation of electric current in the world.

The motor business performed by the company is an unusually large one, the cheap rates at which current can be delivered having brought this about. For instance, every printing press in town is run by a motor; the bulk of the elevators, both direct acting and hydraulic, use the same current, and as the company is able to supply the current at $4 per horse power per month on large motors, there is every likelihood of the business increasing very rapidly. Even to-day the company is running more motors than are run in any city in the West, not even excepting San Francisco. In the elevator department is running a direct 10 h. p. motor in the six story block of Holley, Mason, Marks & Co., and a direct 15 h. p. motor in the Nichols block. This latter is a passenger elevator motor made by Otis Bros., with Eickemeyer attachments, which was the first of its kind to be introduced on the Pacific Coast.* Another Otis elevator runs in the Granite and Mohawk blocks, and Crane elevators in the Hotel Spokane, Eagle block and Auditorium building; while contracts have been made for the equipment of electricity to operate five elevators in other blocks now nearly completed. The motor and light circuit at present keeps two pair of No. 16 Edison dynamos tolerably well loaded in the day time. The company is arranging to equip its new 500-volt generators for the purpose of handling street railroad business in the city, and other large motor work. A large number of fans are operated in different buildings. A horse-currying machine driven by electricity astonishes the innocent cayouse in one of the stables, and the small boy has created a corner with his electrical boot brushing machine for 10 cent shines. There is probably no town in the United States where the spirit of electricity more largely pervades the everyday life of the community.

The officers of the company are F. Rockwood Moore president; John W. Chapman, vice-president; J. D. Sherwood, treasurer; W. S. Norman, secretary and general manager, and John B. Fisken, electrician. The stockholders include some of the most prominent capitalists of the city. The capital stock of the company is $200,000, fully paid up.

An Electric Plant for Water-Works.

The Board of Trade Building at Indianapolis, Ind., is to be equipped with a system of water-works, the power for which is to be furnished by electric motors. The contract for the plant has been awarded to Messrs. Farrell & Co., of Indianapolis. They guarantee to keep the plant in good order for two years. The total cost of the apparatus will be $2,150. The successful installation of this plant will doubtless be followed by others of a similar character.

Efficiency Tests of Motor and Pump.

A very interesting test has recently been made by the Thomson-Houston Motor Company of the efficiency of an electric pump. The particular combination tested was that of a large Gould pump with a Thomson-Houston motor, and the special objects of the investigation were to determine the actual efficiencies of the combination. The results shown are certainly very creditable both to the motor and the pump, for the combined efficiency is exceedingly satisfactory. The experiments were made in actual pumping work, and the following table shows the efficiency at different water pressures:

Lbs. per sq. in.	Efficiency, per cent.	Lbs. per sq. in.	Efficiency, per cent.
0	7 to 10	100	67 to 68.2
20	47 to 50	125	67.5 to 68.6
50	60.2 to 61.5	150	65.4 to 67.2
75	64.3 to 67.4		

In the above tests water was lifted 52½ inches in addition to the pressure of discharge given. The test on friction without moving the water at all is as follows:

Strokes per minute.	Horse power.	Strokes per minute.	Horse power.
20	.96	40	2.20
25	1.23	45	2.60
30	1.57	49	2.98
30	1.82	30	1.52
35	1.78	30	1.88

The power consumed in running light was carefully tested throughout the experiments. The pump ran very smoothly without appreciable heating of the bearings, even when ran continuously, and the current was practically noiseless. After making all corrections the following total efficiency was reached:

Pounds per square inch.	Revolutions per minute.	Efficiency.
0	50	.072
20	45	.47
50	35	.615
75	30	.674
100	30	.682
125	25	.675
150	25	.672

These tables certainly show the excellent results that can be obtained by the use of the electric combination pump, and are exceedingly creditable to the companies whose apparatus has united to produce so excellent a result.

*See The Electrical World, July 5, 1890.

Some New Forms of Dynamos.

BY F. L. O. WADSWORTH.

In view of the recent great activity among electrical inventors, and the great number of new forms recently brought out, I am by no means certain that the machines to which I wish to call attention are new to all readers. They have not, however, to my knowledge been described and as they seem to possess certain advantages in the way of low speed, high efficiency and simplicity of mechanical construction which may, perhaps, make them of some practical value, I will give a brief description of two or three machines which I have recently designed.

In this connection I also wish to call attention to a design of a machine, the principle of whose operation is identical with that involved in Prof. Thomson's new machine recently described in THE ELECTRICAL WORLD.* The design was communicated to me more than a year and a half ago by Mr. B. G. Lamme, M. E., now with the Westinghouse Company. The theoretical importance of this class of machines is so great that the description of another form, somewhat simpler in mechanical construction than the one already referred to, may not be out of place.

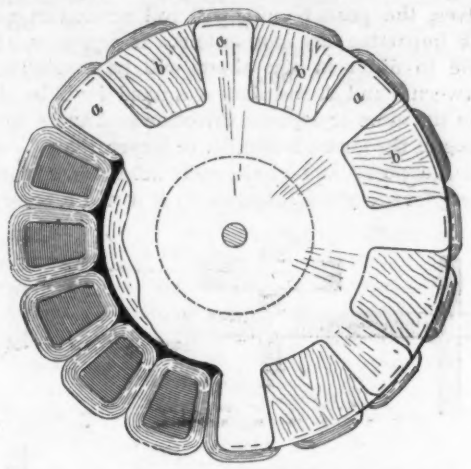


FIG. 1.—ALTERNATOR ARMATURE AND POLES.

Fig. 1 shows an end view of the machine with part of the revolving portion of the field magnet cut away in order to render the armature coils clearly visible. Fig. 2 is a longitudinal cross section. The revolving part of the field consists of a single piece of iron, cast or wrought, with radially projecting pole pieces *a*, *a*, *a*, between which are fitted blocks of wood *b b* to prevent air disturbances and lessen the resistance to rotation.

The armature coils are twice as many in number as the revolving poles, and were, I believe, originally designed to be wound up out of thin copper ribbon instead of wire, because of the greater compactness of the winding, a construction similar to that employed in the armatures of the Mordey, the Ferranti and the new Brush machines. These coils may be either wound directly in grooves cut across the end of the laminated portion of the field or preferably on separate removable cores, which are afterward clamped in

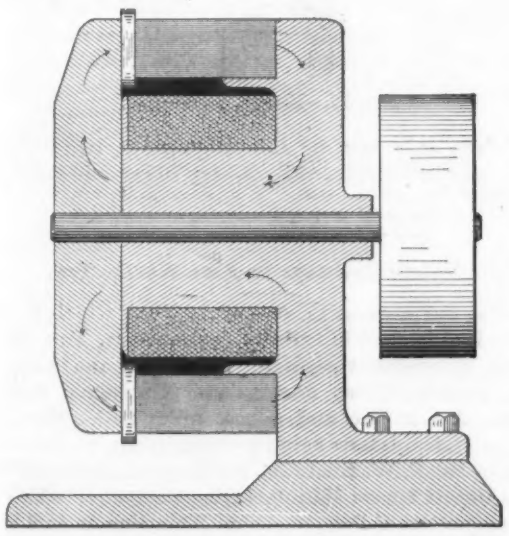


FIG. 2.—ALTERNATING DYNAMO.

place against the end of the field. The stationary part of the field consists of a casting on which is first wound the exciting coil, and then a casing of sheet iron, against the outer end of which the armature coils are placed.

It will be seen that in this as in Prof. Thomson's machine there is no external magnetic field, no commutator (unless direct currents are desired), and no sliding contacts; and that, as already stated, the principle of its action is exactly the same. It possesses, I think, some mechanical advantages over the former, as there are a less number of parts, not so much fitting, less weight in the revolving parts, and more convenient arrangement of the armature coils, which may be removed or adjusted while the machine is running. For reasons of symmetry I think that it would be desirable to double the thickness of the revolving portion and place another stationary part exactly similar to the one already described at the left, the two parts being bolted to a common bed plate.

Of the special forms which I shall now proceed to describe the first (in order of design) is a machine of the so-called unipolar type, a type to which a large amount of attention has recently been deservedly called, because of the great simplicity both of its electrical and mechanical construction, the steadiness and uniformity of current flow, and the large output per pound of metal. The great difficulty with such machines has been to obtain a voltage high enough for commercial purposes. In order to obtain such a voltage it has been necessary heretofore either to drive one machine at an excessively high rate of speed or else to couple a number of machines in series. As has been shown by Prof. S. P. Thompson, Hering and others, no series arrangement of windings is possible in a strictly unipolar machine, and in order to join successive windings in series sliding contacts must be used. This introduces another difficulty in the shape of friction. Brushes have been used with a fair degree of success in machines designed by Siemens (rotating hollow cylinder), Forbes, Polechko and others, but if a number of inductors are to be joined in series by means of sliding contacts the multiplication in the number of the brushes becomes objectionable both on mechanical and electrical grounds. Furthermore, if the inductors be in the form of discs rotating in a uniform magnetic field, the use of brushes bearing at isolated points of the circumference will deflect the stream lines and cause cross or eddy currents in the disc unless the latter is cut radially. If, however, the field is uniform and symmetrical with the axis of rotation, viz., if the outer and inner boundaries of the field are concentric circles having that axis as a centre, and the centre and circumference of the disc be connected to conductors of sufficient capacity,

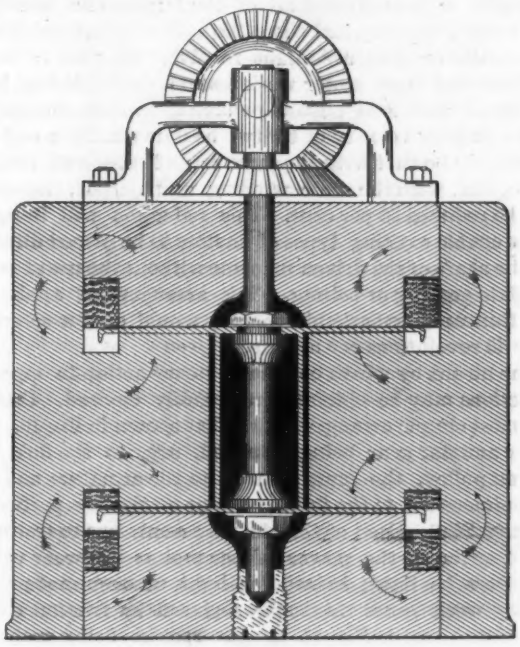


FIG. 3.—HORIZONTAL DISC DYNAMO.

it may be proven that the rotation of the disc in such a field produces a flow whose equipotential lines are concentric circles and whose stream lines are therefore radii. In fact, these conditions can never be satisfied, although practically they may be so nearly satisfied that it is unnecessary to slit the disc radially.

Furthermore, the employment of a field like that just described makes it possible to utilize nearly the entire amount of copper in the disc as a conductor of current. The means taken to secure the two necessary conditions just referred to, viz., a uniform and axially symmetrical field, together with a high voltage without excessive speed, are shown in the accompanying figures.

Fig. 3 is a cross section showing the position of the discs, the exciting coils and the magnetic circuit, which is, as will be seen, perfectly closed with but one air gap, there being no external magnetic field. *A A* are the two revolving discs which are mounted on and driven by the same shaft, the magnetic field being so arranged that while the current flows from the centre to the circumference in one disc, it flows from circumference to centre in the other. Each disc is built up either of a number of thin copper plates insulated from each other, or of a number of segments each of the full thickness of the disc insulated from each other after the manner of commutator segments. Corresponding parts of the two discs are connected with each other at the centre by a system of concentric circular tubes or bars, also insulated, and contact is made along the entire outer circumference of each part by attaching to it by soldering or welding (electrically) a band or rim which revolves in a trough filled with mercury, as in Fig. 4, which shows in cross section the group of concentric circular troughs. The base and the division rings are made of rubber or some other insulating material, and a well amalgamated copper band with the upper edge turned down is placed in each trough, to serve the double purpose of conducting away the current and preventing the overflow of the mercury while the disc is in motion. By this method a very considerable part of the friction caused by a sliding contact is avoided, and the electrical resistance, which is very considerable in the case of brush contact, may be made almost negligible. The separate parts of each disc are connected in series with each other with the least possible amount of dead wire by connecting successive troughs, as shown in Fig. 4, the two line terminals being *a* and *b*.

The largest output will be secured when the separate parts of the two discs are in the form of sectors of solid copper as shown in a top view of one of the discs, Fig. 3 *A*. Diametrically opposite segments make connection with the same mercury trough for reasons of symmetry. To find the number of sectors required, consider a case in which the external diameter of the field is 24 inches, the internal diameter eight inches. The area of the pole pieces will then be about 395 square inches. Assume an air gap whose

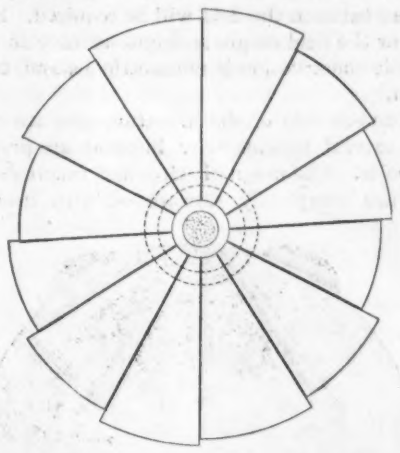


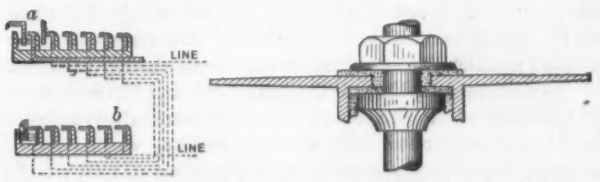
FIG. 3 A.—DETAIL OF DISC ARMATURE.

mean width is one-fourth inch. With such a width and with wrought iron poles a density of 90,000 lines per square inch can be obtained. The number of lines of force cut each revolution will then be about 35,500,000 and the electromotive force induced in a conductor cutting this field at a speed of 1,500 revolutions would be nearly 8.9 volts. Twelve sectors in series (six in each disc) would give therefore an electromotive force of 107 volts.

To find the current which could be carried we have, allowing .09 of an inch (not quite $\frac{1}{11}$ of an inch) for clearance, for the mean cross sectional area of each one of the copper sectors about .628 square inches, which by the ordinary rule (520 mils per ampère) would carry 1,200 ampères. The two opposite sectors in parallel would therefore carry 2,400 ampères, and the total output of the machine would be 256,000 watts. Further calculation shows that with a density of 80,000 in the magnet cores, the total weight of the iron in the field circuit would be less than 10,500 pounds. The weight of copper in the field would be 680 to 690 pounds, and the weight of copper in the discs and connections would be 200 to 210 pounds. Allowing 600 to 700 pounds for shaft, pulley, gears, insulation, etc., the total weight would be less than 12,000 pounds, and the output would therefore be 21.3 watts per pound of weight and 284 watts per pound of copper used.†

The design to which I next wish to call attention is that of a machine in which the armature is of the ring type. The field is in this respect novel, in that both internal and external poles, *placed opposite* to one another, are used, the opposing poles being of the same polarity. In the form of machine due to Mariotti, recently described in THE ELECTRICAL WORLD, both internal and external poles were used, but they were arranged alternately. This latter arrangement, while it possesses some marked advantages, as there pointed out, is open to the objection that one-half of the wire on the armature is dead.

In the present proposed arrangement of opposite poles of the same polarity the wire, both on the interior and exterior of the ring, is employed in generating useful electromotive force, so that a ring with a given number of wind-



FIGS. 4 AND 5.—CONNECTIONS OF DISC ARMATURE.

ings and running at a given speed will generate double the electromotive force that would be generated in case either external or internal poles alone were used, provided the section of the armature core be increased sufficiently to carry the additional lines of force which will pass through it in the former case.

Fig. 6 is a cross section through the centre of the armature and field of a six pole machine, showing the arrangement of the windings of the exciting coil and the magnetic circuit. It will be seen that the arrangement of the windings is such that for those which produce the interior poles there is no external field; in the case of the exterior windings this is true of one side of the coil (that next to the armature) only. The windings being brought

*See THE ELECTRICAL WORLD, Aug. 2 and 9, 1890.

†Since the above was written I have been at work upon a unipolar machine in which no sliding contacts are used, and all inductor wires are stationary, the details of which I hope to have ready soon.

out flush with the pole pieces, prevent a direct passage of the lines of force between the poles, the outer layers of wire serving to force the lines through the armature. The poles may therefore be brought very close to each other, and all the advantages of M. Mariotti's arrangement realized.

The amount of dead wire on the armature becomes very small indeed, much less than is necessary on a drum armature of the most favorable type of construction, and the output of the machine per pound of copper used is by that much increased. There is nothing more difficult in the mechanical construction than in the case of the ordinary machine. The inner field, armature core and outer field may be stamped with little loss out of the same disc of sheet iron, even for large machines. There are no joints in the magnetic circuit, and it is moreover very short ; therefore few amperè turns on the field will be required. Either the armature or the field magnets might revolve as desirable, as the whole construction is symmetrical about the centre of rotation.

If poles on one side of the armature only are employed, there are several reasons why internal are preferable to external poles. The magnetic circuit is much shorter, the windings are completely surrounded with iron, and the

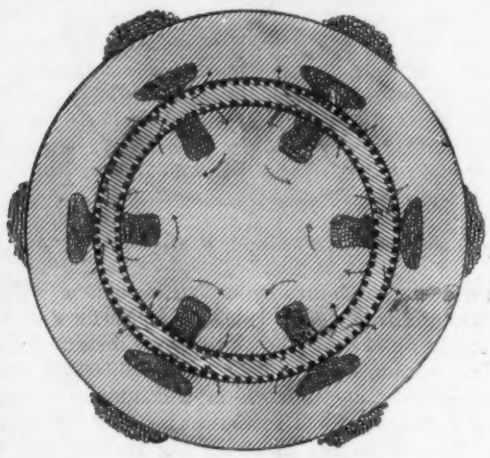
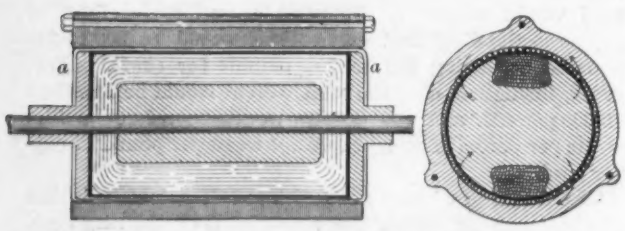


Fig. 6.—Modified Gramme Dynamo.

field is of such a form that it may be made without joints and of wrought iron, either solid or laminated. The winding of the field is very easy; in fact, the winding on a two pole machine is the same as that on the old form of Siemens "shuttle" armature. In addition to these advantages, the armature may be made of very large size (in fact, the diameter would necessarily be greater than in machines with external poles) without increasing the size of the machine, the external dimensions of the armature determining, in



Figs. 7 and 8.—Modified Drum Armature Dynamo.

fact, the external dimensions of the machine. This possible increase of size means, of course, a possible decrease of the speed of rotation, for with a given inductor velocity the angular velocity varies inversely as the diameter of the armature. With this construction it is possible, even desirable, to rotate the field magnets rather than the armature, and although the windings of the field are also in motion, there is little trouble in securing them in such a way that there is no danger of their becoming loosened.

The clearance between the pole pieces and the armature wires may, as in case of all machines in which the armature wires are stationary, be reduced to the smallest possible amount. Even if the armature be revolved instead of the field, centrifugal force keeps the armature coils pressed against the cores and away from the field instead of the reverse, avoiding all danger of ruining the armature by breaking of binding wires. Other mechanical advantages might be mentioned, such as best possible ventilation of the armature, easy removal, or replacement of any of the armature coils, etc.; but enough has been said to call attention to some of the more important advantages of this type of construction. On the other hand it may be said that the armature is more liable to accidental injury; that the iron of the field will be heated somewhat more by the current in the exciting coils, because of its inclosed position, and that revolving brushes are objectionable because they require an additional pair of collecting rings.

From the last described form we pass easily to another in which the armature is of the drum type. The relative position of the field and armature core is the same as before, and the same statements would apply to this as to the preceding machine. The armature could be wound by placing the two end pieces *a a* (Fig. 7) in position, winding on the wire as usual, and then slipping the armature core over the windings. When finished the field would be completely enclosed, and it would be impossible to obtain access to it without unwinding a portion of the armature. The field would therefore have to be wound very carefully and securely in order to prevent the necessity for any such proceeding.

This form may be again slightly modified so as to give us that shown in Fig. 9. In this the armature has no iron core, but is built up of commutator-shaped bars connected across the ends by wires or discs. The outer shell of iron revolves with the inner field, and there is therefore no reversal of magnetization in any part of the field and no external field. There is necessarily a double air gap, but the additional air space thus introduced is slight, because the clearance may be made less than that allowable when wire windings are used and the thickness of the insulation be-

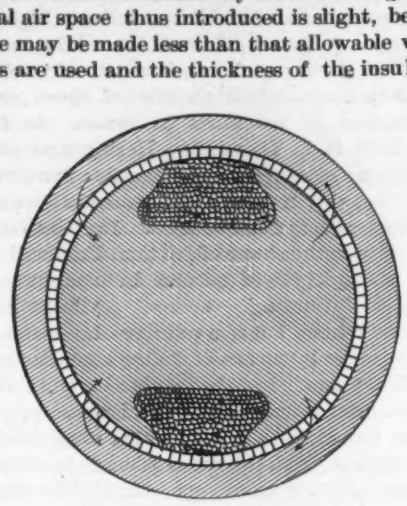


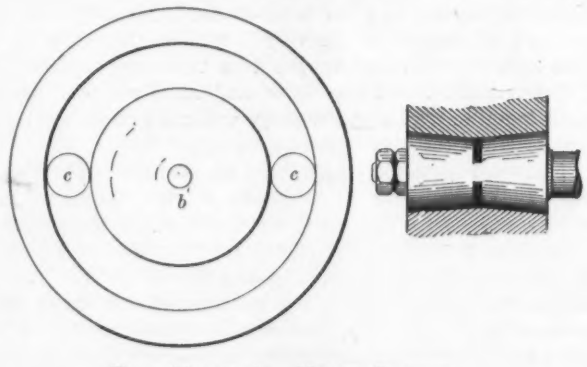
Fig. 9.—Simple Dynamo.

tween two layers of wire is saved. Whether, however, the advantages to be gained from the elimination of hysteresis would compensate commercially the somewhat increased cost of construction can only be answered when special conditions are assumed.

It will be noticed that all of the forms so far described are equally symmetrical about the axis of rotation, so that either field or armature might revolve. In case of some dynamo and most motor work it seems desirable that both armature and field should revolve in opposite directions. If the angular velocity of the two be numerically equal the result will be that with the same rate of cutting of lines of force, viz., with the same winding and output, the speed will be reduced 50 per cent. This reduction will in many cases enable existing types of motors to be placed directly on the shaft of the driven machine without the use of intermediate gearing or belting. This arrangement applied to Dr. Duncan's remarkable motor‡ would give a speed of only 45 revolutions per minute.

The means by which combined rotary action in opposite directions may be obtained are readily devised. One of the most simple arrangements is that shown in Fig 10, the outer annular gear being attached, say, to the field and driven pulley, the inner gear *b* to the armature and the two pinions *c c* to the frame or some stationary portion of the machine. Each of the pinions *c c* only has to transmit one-quarter of the power of the motor; the wear would therefore be light; indeed for light or even moderately heavy work gears might be replaced by friction cones, made as shown in Fig. 11, the construction being such that any desired degree of pressure between the driving surfaces may be obtained without any thrust on either bearing, and any wear readily taken up. With this arrangement the angular velocity of armature and field is not quite the same, but may be made very nearly the same by making *a* and *b* of sufficient size. Exact equality is not however necessary.§

In street car work both axles could be driven directly from one motor without any rigidity or hard driving ac-



Figs. 10 and 11.—Motor Gearing.

tion by attaching one axle directly to either armature or field and the other axle to field or armature; any irregularity of motion between the two is then perfectly provided for without the use of springs or other perishable arrangements even more satisfactorily than by the use of two independent motors which do not always pull together with as much harmony as might be desired. There are various means by which motion might be communicated from one part of the motor to the more remote of the driven axles, two ways being shown in Fig. 12. In any case the gears employed may all be of large size and the wear and resultant rattle, consequent upon the use of small pinions is avoided.

‡ See The Electrical World, May 17 and July 12, 1890.
§By reducing the size of *b* and increasing that of *c*, this same arrangement would serve as a very efficient friction gearing between low-speed engines and high-speed dynamos, which could be thrown into operation or out by tightening or loosening the nuts which hold the two parts of the cones *c c* together.

There is one other suggestion which I wish to make, and that is in regard to a system of gearing that might advantageously be applied in gearing down high speed motors of considerable power. The proposed arrangement is shown in side elevation in Fig. 13. Only four gears are employed in obtaining any reduction from 1 to 5 to 1 to 100 or more if desired, and these gears are all spur gears of very nearly equal size; *being more nearly of equal size the greater the reduction* of speed. *A* is the high speed (driving) shaft, *B* the low speed (driven) shaft; *a* is a fixed gear, *d* the gear on the driven shaft; *b* and *c* two gears revolving together with a shaft *D*, which takes its bearing in the end of the piece *C*, which is keyed to and revolves with the driving shaft. Suppose, for simplicity, that the two gears *a* and *b* are of equal size, then it is clear that if the two gears *c* and *d* are also of equal size when the part *c* revolves, the gears *b* and *c* will roll around on *a* and *d* without imparting any motion to *d*. If, however, *c* and *d* be made to differ in size there will be a relative motion between *a* and *d*, and since *a* is fixed *d* will be driven either in the same or opposite direction as *A* and *C* revolve, according as the gear *c* is smaller or larger than *d*. As an example, suppose *a* and *b* have each 100 teeth. *c* 99, and *d* 101; then, for every revolution of *A*, *B* would revolve in the

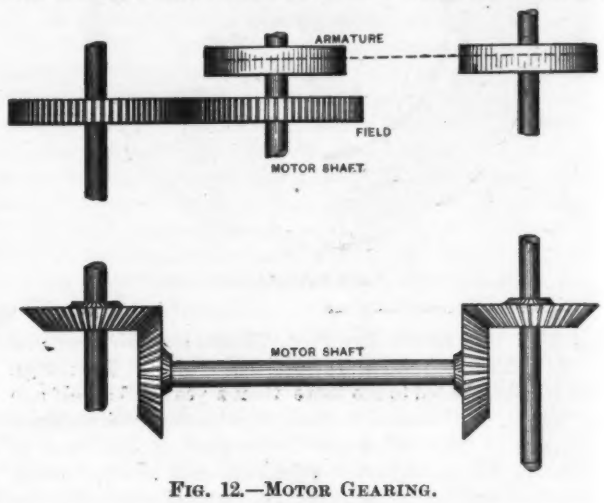


Fig. 12.—Motor Gearing.

same direction an interval of two teeth, or the ratio of the speed of *B* to that of *A* would be $\frac{2}{101} = \frac{1}{50}$ nearly. For a reduction of speed from 10 to 1 approximately, as ordinarily used in street car motor work, the number of teeth in *c* and *d* would be 95 and 105. By placing two more gears which have a different velocity ratio by the side of *c* and *d*, with a clutch arrangement, whereby either of the gears on

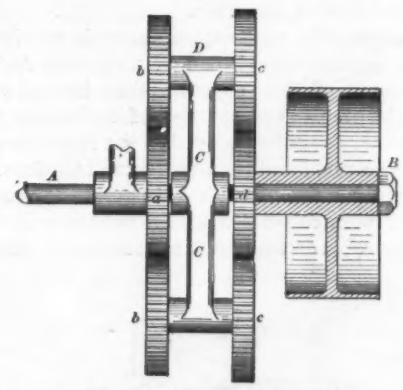


Fig. 13.—Motor Gearing.

the driven axle may be engaged with it, two different speeds may be provided for at very slight additional expense.

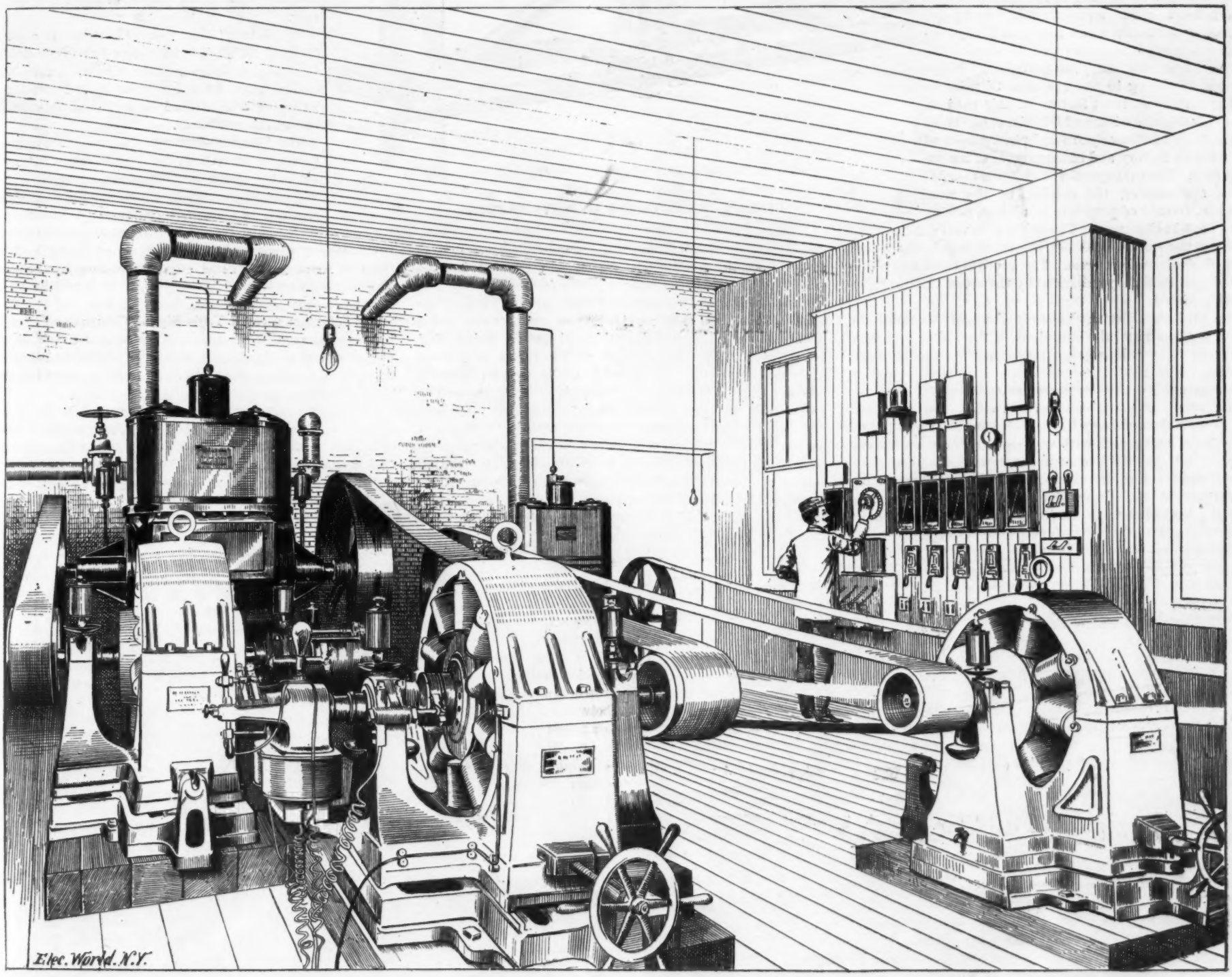
Electric Railways in Fort Worth, Tex.

Among the progressive cities of the West which are taking the lead in electric railway construction, Fort Worth occupies a prominent position. Several of the most successful electric railway systems are represented upon its streets. A line five and a half miles in length of the Sprague system is now being constructed under the supervision of Mr. F. W. Brady, of the Mountain States District of the United Edison Manufacturing Company, which has its headquarters at Denver, Colo. This line is said to be one of the finest in appearance in the West. It has a single line of poles, set in the middle of the street, or rather boulevard, which is 125 feet broad, nearly straight, and has only very light grades. The poles are shaved, roofed, and painted white, except seven feet at the base, which is painted black. Ornamental mast arms are used. The cars were furnished by the Pullman Company. The central station which furnishes the power is a model of neatness. Two Heine safety boilers furnish the steam. A Hamilton-Corliss engine drives the compound wound Edison dynamos. The road is built into a suburban section of the city which is as yet not very fully developed. The city also has an electric railway of the Thomson-Houston system which is giving excellent satisfaction. The Fisher-Rae system is also represented by a good line. Each car of this type is equipped with only one motor, that being geared to both axles by bevel gears. The motors are doing good service, and the cars are said to run with very little noise. A system of the new Westinghouse type is also proposed.

An Electric Light Plant at Uniontown, Pa.

The Uniontown Electric Light and Power Company's plant, of which an interior view is given in the illustration on this page, has been in operation nearly a year. The power house is a very substantially built one-story brick building, measuring 28×40 feet. The entire plant was put in by the Westinghouse Electric Company. The electric plant consists of one 450-light Westinghouse alternating incandescent machine, with separate exciter; one 750-light alternating incandescent, with exciter, and one 60-light Westinghouse alternating arc-light dynamo of the latest type. The engines, of which there are two, are respectively 50 and 80 h. p., and are of the Westinghouse type known as the "Junior" automatic. Munson belting is used throughout. Two tubular boilers of 60 and 100 h. p. furnish the steam. These are supplied by two injectors, and are fitted with safety blow-off whistles which sound an alarm at either high or low water. The furnaces are fitted to use either natural gas or slack as a fuel, and owing to the scarcity of gas, coal is now mostly used. The switch and instrument board shown on the right of our illustration reaches from floor to ceiling, and is made of oiled hemlock. The bus-rods are on the back of the board, and as a matter of course all the lines and connections to the voltmeters, ammeters and resistance boxes come in from the back and are very neatly concealed.

The company has about 1,300 lamps of 16 c. p. each in use—the full capacity of the station at present. It is understood, however, that another incandescent dynamo of the Westinghouse pattern is to be added at an early date. The company has orders ahead and buildings wired for a large number of lamps. Uniontown is supplied from this plant with 56 arc lights for the streets. All the lamps are suspended from 16 to 20 foot Brady mast arms over the middle of the streets. In addition to the arcs for street lighting, a number of commercial arcs are in use, principally by the most prominent merchants. The company has a very complete plant in every particular, and there seems to be no reason why a very encouraging dividend should not be the result of its operation. The managers seem to have realized that a well ordered station is one of the first requisites to a successful business enterprise.



INTERIOR VIEW OF THE WESTINGHOUSE CENTRAL STATION AT UNIONTOWN, PA.

A New Supply House in New York City.

We are informed that a new company has been organized to engage in the sale of electrical supplies with headquarters in New York City. The company will be made up of three gentlemen, already well known to the fraternity, viz.: Messrs. Alexander, Barney and Chapin, who have secured the large and commodious store in the Telephone Building, No. 20 Cortlandt street. All of these gentlemen have been connected with the Sawyer-Man Electric Company, of New York, as general manager, treasurer and purchasing agent, respectively.

Mr. P. H. Alexander is to have charge of the sales department in the new firm, and may be said to be "the right man in the right place." He has been engaged in the electrical business from the early days of electric lighting, beginning with central station work, the installation of plants, etc., in connection with the business of the Thomson-Houston, Sawyer-Man and Westinghouse Electric companies in New England. As a result of his marked success he was appointed general manager of the Sawyer-Man Electric Company, and the phenomonal growth of that company in the past few years is excellent proof of his able management. Outside of his regular official work, Mr. Alexander has been interested in various undertakings. He has been president of the New England Electric Exchange, of Boston, Mass., and assisted in harmonizing the insurance and electrical interests in New England. Mr. Alexander is now a member of the National Electric Insurance Bureau, which is framing rules for the United States, to be observed in the installation of machinery, etc., for electrical purposes. With hosts of friends and a varied experience from constant activity, Mr. Alexander is well fitted to be at the head of the new firm.

General C. H. Barney began in the telephone business in 1879, resigning for that purpose his position as treasurer of the Providence Gas Burner Company, with which he had been connected for ten years. After two years experience in Providence and Boston, during which time he constructed the first long-distance telephone line between those cities, in December 1881 he was called to the management of the New Jersey Telephone Company, which position he held until his resignation in 1886, at the organization of the Sawyer-Man Electric Company, of which he is now the treasurer. He was one of the charter members of the New York Electric Club, and is at present a member of its Board of Managers. He has been since 1885 the secretary of the National Telephone Exchange Association. The General, like his colleague Mr. Alexander, has a large acquaintance with electrical men and has many personal friends. As treasurer of the Sawyer-Man Electric Company, he has had an experience in the management of finances which will be of great value to the new firm.

Mr. Charles E. Chapin, the third member of the new company, entered the electrical field as secretary of the Waterhouse Electric and Manufacturing Company, of Hartford, Conn. On the sale of that company to the Westinghouse Electric Company, and the removal of the works to Pittsburgh, Mr. Chapin was transferred to New York, and became the purchasing agent of the Sawyer-Man Electric Company. The rapid growth of the business of that company, both in the supplies furnished to central stations and the innumerable wants of a large factory, has required great activity in the purchasing department, and Mr. Chapin has proved himself to be a successful buyer.

The new store will be ready about Oct. 1, and the firm will represent manufacturers of goods adapted to the electrical trade, as well as keep in stock a line of general electrical supplies. In representing inventors and manufacturers, the new firm, from the wide experience of its members, will be particularly able to place the goods in the larger channels of the trade of the country. The new insulating material, which is now receiving considerable attention, called "Alexite," will be under the control of Alexander, Barney and Chapin. The material can be made into any shape, and has the properties required for cut-outs, switches, etc., being fire-proof, water-proof and acid-proof. Any color of wood, paper or marble can be imitated, so that harmony of the attachments in wiring with the color of the materials in the room is attained. Messrs. Alexander, Barney and Chapin will occupy the same positions in the new firm as were filled in the Sawyer-Man Company, and start with a large experience in their respective departments. We wish the new firm the greatest prosperity in its venture and all the success that can come from the happy combination of unusual business talents with the good fortune that we trust will attend them.

Some Electrical Features of the St. Louis Exposition.

The annual opening of the St. Louis Exposition Wednesday evening of last week was fairly well attended, and the entire building was beautifully illuminated throughout with arc and incandescent lights. The electrical department occupies the same space in the basement as last year, and is under the same management, but whether the exhibit will be as good remains to be seen. On the opening night there were but six complete exhibits in position.

Occupying the first position on the left is the space secured by the Southern Electrical Supply Company, of St. Louis, whose exhibit last year was voted one of the handsomest and most attractive among the entire number. The present exhibit, while partaking of the same general character, is superior in many respects, and includes several new specialties of interest to the central station manager, the contractor and the general public, the most prominent being the Kulp fountain column fans, that have in addition to the fan blades an arrangement that automatically discharges streams of perfumed water into small cups arranged so there is no waste, and the same water can be repeatedly used, the perfumed breezes proving refreshing to the visitors. Okonite, of course, is the prominent feature of this exhibit. There are Okonite wires and Okonite cables of all dimensions; handsomely framed photographs of the Okonite factory and of the process of manufacturing. Then the eye of the visitor is caught, when approaching the exhibit, by the word Okonite, formed of porcelain insulators, resting on a dark background. Circling that household word are the words, Southern Electrical Supply Company, formed of ash push-buttons. The booth is artistically decorated, and its beauty enhanced by the use of electric lights suitably placed.

The St. Louis Electrical Supply Company occupies the adjoining booth and the attention of the visitor is at once attracted by the large sign extending across the front reading "Electrical Headquarters." It is the keynote to the company's desire to make its space the temporary headquarters of every visiting electrician, and with that end in view the company has carpeted the floor and placed easy chairs and a desk with writing materials at the disposal of all guests. The arrangement of the display is unique and varied in character, and comprises nearly everything in the supply line. This company is giving special prominence to the display of eight Crocker-Wheeler motors which it is handling in the interests of the Crocker-Wheeler Motor Company, of New York.

This company is also showing the automatic clocks that are of service in automatically cutting electric lamps in and out of circuit at stated hours, and which are manufactured by the Automatic Clock Company, of Syracuse. Another special exhibit is the rich collection of Habirshaw wires, cables and conductors affixed to the mahogany sample board that has attracted so much attention at various conventions, this board being temporarily loaned by the Electrical Supply Company of Chicago. The attractiveness of the booth is enhanced by the 250 colored incandescent bulbs placed in various positions by the Columbia Incandescent Lamp Company, of St. Louis, which is furnishing the majority of the incandescent lamps used throughout the building.

The Russell Electric Lamp Company, of Boston, is next in line with a complete display of its standard arc lamps which are being used on many circuits in place of the ordinary double carbon lamp, as they will burn on the ordinary arc current from 8 to 24 hours with one pair of carbons, and are said to produce a greater amount of electrical energy and with less expense than many of the arc lamps now on the market. The display is one of interest and value to every one owning or operating an electric arc light plant, and worthy of a visit.

The Unicycle Electric Elevated Railroad Company, of St. Louis, Mo., has erected an elevated track for a short distance, on which it is running a small model truck, with seating capacity for two passengers. In constructing the track the company uses one main rail and two guide rails, the main rail being supported by posts and uprights, while bolted to the main rails are side braces having curves at the lower end, in which rest the guide rail, also securely bolted in position. The main wheel of the truck is grooved and rests on the main rail, while smaller grooved wheels, supported from cross bars, fit into the guide rails and practically lock the truck to the track. The car bottom and truck frame are movably connected, having friction rollers that play between the car bottom and truck frame, working in a flanged disc. The friction rollers rest on springs which are supported by an under brace, thus allowing the car to turn a short curve with ease and safety. The motor is so constructed that the weight will be equally balanced on the truck frame, while an automatic device is so arranged as to equalize the weight on centre, making it entirely centrifugal and taking off all unnecessary friction. A "C. & C." motor is being used to operate the car. The system is illustrated on this page.

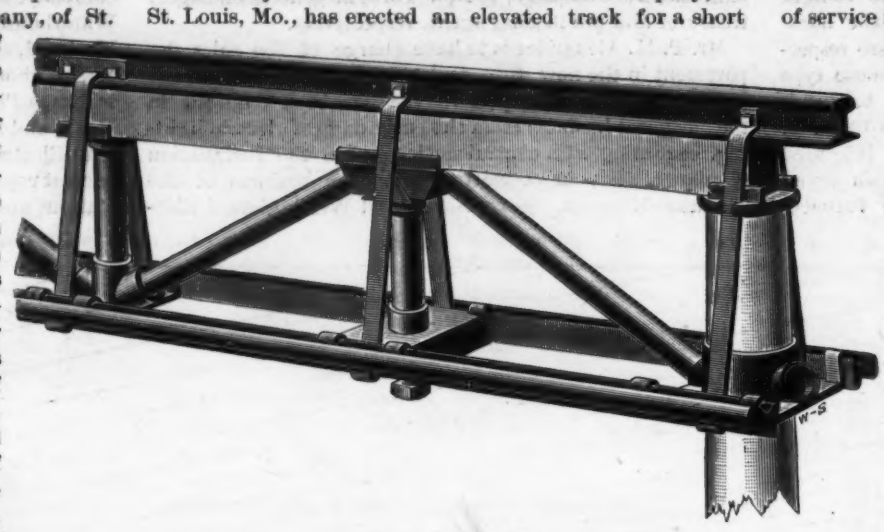


FIG. 1.—UNICYCLE RAILWAY TRACK.

The Rose Electric Light Supply Company, of St. Louis, has an excellent exhibit of second hand dynamos, motors and arc lamps, neatly placed in attractive order. It is a display that will prove of interest to every prospective purchaser of electric lighting apparatus, and no doubt will result in the sale of the entire lot before the season is over. This company also has the contract for supplying the incandescent lights used in a large number of the exhibits and for electric motor work, using Edison dynamos for this purpose.

The Shultz Belting Company, of St. Louis, is making a more complete exhibit than it had last year, and is showing its "fulled leather belting," the new "woven leather link belt," composed entirely of leather and doing away with the iron rod, and the patent leather covering. It is an exhibit that will prove attractive to every power user.

The National Electric Manufacturing Company, of Eau Claire, Wis., has one of its handsome 1,000-light alternating current dynamos in position with the necessary transformers and switch boards, and is furnishing light to many of the lamps that add so much to the beauty of the scene. It is one of the attractive exhibits and will no doubt prove of service in illustrating to all interested visitors the simplicity of the system. Several additional features will be shown by this company later on.

The Parker Russell Mining and Manufacturing Company, of St. Louis, has a display somewhat similar to that of last year, and in the same space, and its trade mark "Sunlight" looms up bigger than ever in gold and black, while carbon cups, pencils, big and little rods and slabs of carbon, are attractively placed on tables easy of access.

The John T. Noye Manufacturing Company, Buffalo, N. Y., is exhibiting a handsome 50 h. p. Rice engine placed in position by its agents, Fairbanks, Morse & Co., St. Louis, Mo. Later on this engine will be utilized in driving a dynamo for one of the exhibitors.

The Thomson-Houston Electric Company is preparing an exhibit that will be one of the largest in the entire section when completed, and will include two 400-light and one 250-light direct current incandescent dynamos; a 12-light arc dynamo and several Thomson-Houston motors; the necessary power to drive the dynamos being secured from an Armington & Sims engine installed by the Pond Engineering Company. Additional features will be added later on.

The Johnston Electric Train Signal Company of Boston has a miniature locomotive and passenger coach standing on a section of track, by means of which the company is enabled to show the system the same as when in practical operation.

Among the companies which have a representative on the ground or whose exhibit will be in position within a week or so, are the Great Western Electric Supply Company, of Chicago; Walter E. Crane, of Minneapolis, who will exhibit the Baker Common Sense oil filter; Jas. W. Queen & Co., of Philadelphia, who will display over $5,000 worth of instruments; Carpenter-Nevins Electric Heating Company, of Minneapolis; the Washington Conduit Company, of Washington, D. C., and the Page Belting Company, Concord, N. H.

Mr. M. Wuerel, of St. Louis, is exhibiting his Ajax snow plow built for practical work on the St. Louis and East St. Louis electric railways.

Foree Bain, of Chicago, is putting the finishing touches to the electric fountain that will prove one of the attractive features of the electrical section.

The Irwin electric train signal system, of Omaha, is attracting attention, owing to its simplicity and apparent efficiency.

Blatner & Adams, of St. Louis, occupy the same booth they had last year on the second floor, and show a full line of house goods, etc. They are also exhibiting a Shallenberger meter connected in circuit.

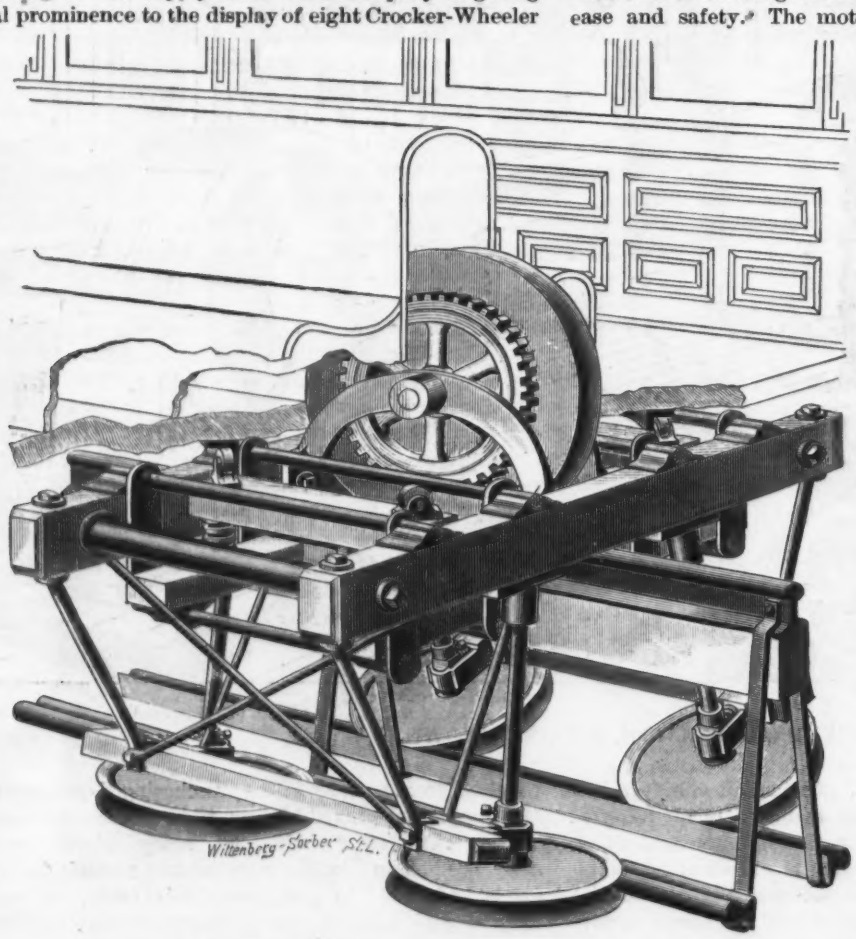
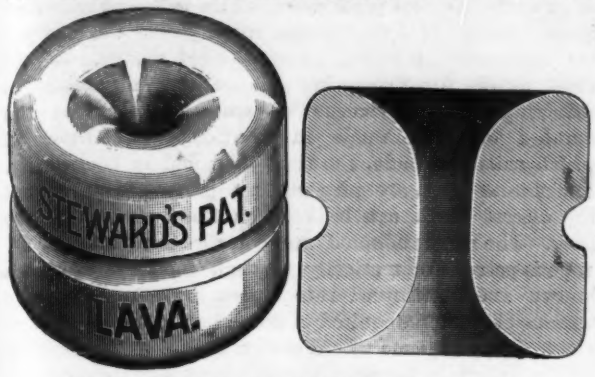


FIG. 2.—UNICYCLE RAILWAY TRUCK.

FIG. 3.—UNICYCLE ELEVATED ROAD IN OPERATION.

A New Lava Insulator.

A recent addition to the already long list of insulators comes to us from Chattanooga, where the Steward Manufacturing Company is turning out large quantities of the neat and inexpensive form shown in our cuts. The material employed is very smooth, hard and strong, while the rounded form of the insulator presents the advantage of freeing the wire from any severe bending strain. The insulating properties of the lava compound are high and it is about as nearly indestructible as could be wished. Natural materials are now being very largely replaced for electrical purposes by various ingenious mixtures, of which the "lava" is one of the most familiar. The illustrations

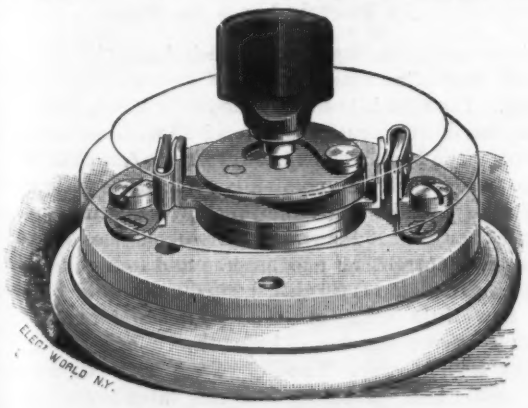


STEWARD'S LAVA INSULATOR.

show both the general form of the insulator and a section exhibiting the smoothly curving surface in which the wire rests. The strength, durability and high insulating qualities are strong recommendations.

An Ingenious Snap Switch.

One of the neatest contributions to the line of snap switches which has appeared for a long time is that illustrated herewith. It is due to the ingenuity of Mr. G. W. Hart, of Kansas City, who was one of the old-timers in electric lighting, inasmuch as he entered the service of the Thomson-Houston Electric Company immediately after its organization ten years ago. Since then his experience has been large in almost all departments of electric lighting, and, like every other electrician, the need of a reliable switch impressed itself most vigorously upon him. The present switch has divers singular merits. In the first place, it has no spiral spring, but a flat steel spring instead. The break and make is instantaneous and the air gap very long. The motion of the switch is rotary, snapping forward a quarter of a revolution at a time. This is effected by a four-part hollow cam in which is carried a stud attached to the switch handle so that at each turn of the handle the arm carrying the contacts is shut through a quarter of a revolution by the flat spring that presses against it. The result is a very perfect rubbing contact, keeping the surfaces perfectly clean and bright. The ten-ampère switch is the one illustrated, and it is available for a current considerably greater, while the long air gap made in the break—not less than one and one-half inches—allows of a 500-volt current being successfully used. The action of the switch is very smooth and certain and the valuable property of a long, quick break is secured without complication of parts. There is very little about it that is likely to wear out, and the use of flat instead of a spiral spring tends to increase its available life. The switch is neatly gotten up, and when put upon the market will be



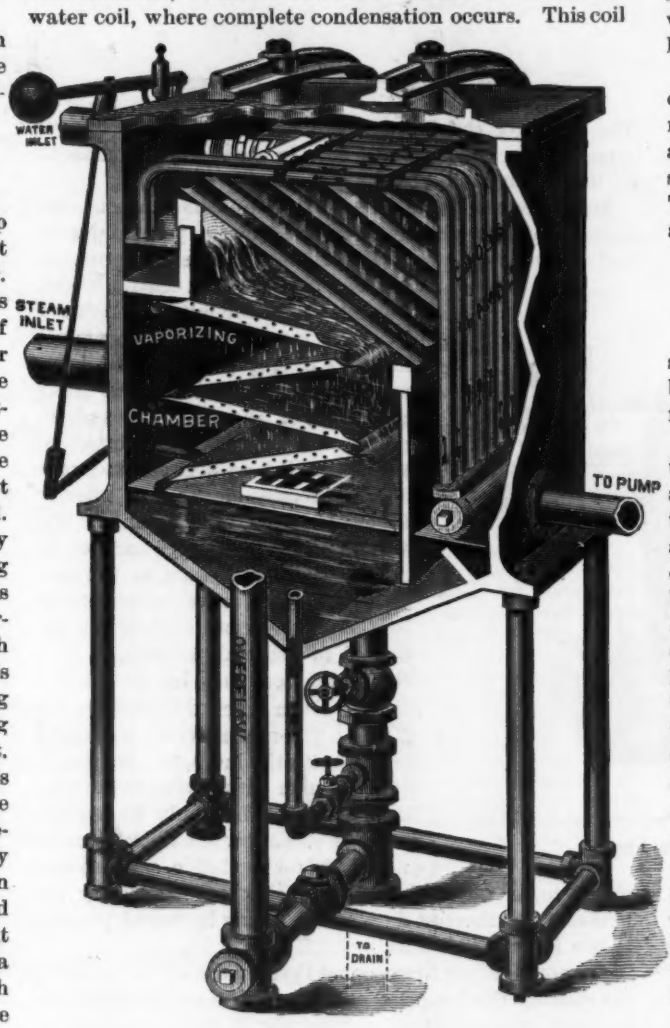
THE HART SNAP SWITCH.

placed upon a porcelain base and covered with a close fitting cap shown by light lines in the cut. A double pole switch of the same type is now in process of construction, and it will soon be ready.

Webster's Vacuum Exhaust Steam Economizer.

The apparatus shown in the accompanying illustration is intended to utilize economically the heat of exhaust steam, by returning the water of condensation to the boiler, and may serve either as a feed-water heater and purifier, or for obtaining hot and purified water for manufacturing purposes; or, if used in connection with a steam-heating plant, will utilize the exhaust steam for heating buildings without back pressure. In this apparatus, the exhaust steam is admitted into a chamber, in which it is permitted to come in direct contact with an extended surface of water, by which it is promptly condensed, and its heat is quickly absorbed. The conditions within the apparatus are such that a partial vacuum is constantly maintained, thereby accelerating the influx of steam from the source of supply. The interior arrangement of the apparatus is such as to effect the condensation of the exhaust steam and the utilization of its heat promptly and effectively; and the means provided for the separation of the impurities contained in the water, and the grease contained in the exhaust, are simple and satisfactory.

The construction and operation of the Webster economizer, which is manufactured by Warren Webster & Co., of Philadelphia, will be understood readily from the following description: It consists of a closed iron shell in the form of a rectangular box, with a doubly inclined bottom, and provided with an inlet pipe for the exhaust and for the cold water (the supply of the latter being automatically regulated by a float connected with the lever which operates the valve), and an outlet pipe leading to the feed pump, from which the hot and purified water is delivered either to the tank or to the boiler, according to its intended service. The case contains a series of oppositely inclined and perforated sheets of copper, intended to spread the water over an extended surface, and to bring it in contact with the exhaust in the central chamber (called the vaporizing chamber), in a state of such comminution as to effect the prompt condensation of the exhaust. The portion which escapes condensation rises to the upper portion of the chamber, where it comes in contact with the cold water coil, where complete condensation occurs. This coil



THE WEBSTER ECONOMIZER.

is formed of a number of parallel pipes bent at right angles, the central group of which is connected with the water inlet. The lower ends of the entire set terminate in a horizontal pipe, and the upper ends of the discharge pipes are bent again at a right angle, and discharge into a trough, from which the surplus flows over upon the copper condensing plates. The water admitted into the central group of the coil passes down into the horizontal pipe above described, as shown by the arrows, then dividing, passes up the group of pipes to the right and left, and is discharged into the trough above, as just described. The feed-water, together with the condensation, having a temperature which may be regulated at will, and which may very closely approximate 210 to 212 degrees, collects in the bottom of the chamber, and is drawn off by the pump through the pipe seen upon the right. A partition extending entirely across the chamber, and whose lower edge extends beneath the surface of the accumulated feed-water, effectually excludes any scum and grease from reaching the pump. These light impurities float upon the surface of the water in the main chamber, and may be drawn off from time to time as may be found necessary, by the scum pipe communicating with the drain. The heavy mechanical impurities, and certain chemical salts precipitated, which collect at the bottom, may be removed in a similar manner through the drain pipe.

It is claimed for this apparatus that it operates much more promptly by reason of bringing the exhaust and the jet water into direct contact, than it is possible to realize with many of the other forms of feed-water heaters, which impart their heat only indirectly to the feed-water, and, furthermore, that the utilization of the heat in the exhaust is much more complete than in any of the indirect forms of apparatus. When applied to a steam-heating plant the apparatus, acting as a vacuum chamber, permits the exhaust steam to be utilized for heating buildings, with most satisfactory results, the condenser relieving the entire pipe line of back pressure and facilitating the rapid circulation of the exhaust.

An Incandescent Lamp Holder.

The accompanying illustrations show a new connection for attaching incandescent lamps to gas chandeliers, which was exhibited at the Cape May convention by the Star Electric Company, of Philadelphia. Fig. 1 shows the plain metal fixture, one end of which is attached to the

FIG. 1.

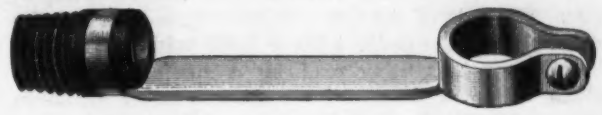


FIG. 2.

chandelier and the other to the incandescent lamp. Fig. 2 shows a fixture of the same style constructed in such a way as to insulate the lamp from the metal of the chandelier.

This attachment is simple in construction and can be quickly and rigidly fastened in position without the removal of the gas burners. It is extremely neat in design and is finished in either nickel, copper or bronze as desired, making it suitable for all varieties of gas fixtures. The arm is made of sheet metal so that it can be bent at any desired angle.

The Hedgehog Transformer.

An English correspondent sends us the following description of the construction and working of Mr. Swinburne's hedgehog transformer, which will be of interest to many of our readers:

"Last year Mr. Swinburne brought forward the theory that an open iron circuit could be made more efficient than any form of closed iron circuit transformer. The loss in a transformer is made up of loss in copper due to resistance, and loss in iron due to hysteresis. In calculating the efficiencies of transformers, the loss in the iron has generally been left completely out of account and the loss in copper alone considered. Hence the efficiencies of 97 and 98 per cent. claimed for closed iron circuit forms. If the loss by hysteresis is taken into account, allowing the losses as given by Ewing, the loss in iron in closed circuit transformers, as usually designed, is some 10 per cent. of the full load. As the loss in iron goes on all the time a transformer is in circuit, this is very serious. The proportion of actual to possible output of energy per day varies in different districts, but in most stations the average use of lamps is less than two hours a day, including all lamps installed. The transformer must be large enough to feed all the lamps installed, so it runs, say, an average of two hours of full load a day. If there is a loss of 10 per cent. of full load in the iron, this gives an actual efficiency of 45.5 per cent., even neglecting the loss in copper. In the hedgehog form

THE 'HEDGEHOG' TRANSFORMER.

the proportion of iron is very much reduced. The cross section of the iron is much less, and the length is about one-third of that of the closed circuit form, as it has not to surround the wire. The result is that even in small transformers the iron loss is under one per cent. of the full load, which gives 89 per cent. all day efficiency, neglecting copper loss, against the 45 per cent. of the closed circuit. This is neglecting copper, however, and the copper loss is greater in the hedgehog form, so this is an exaggerated comparison. Such a transformer really has an all day efficiency of about 87 per cent.

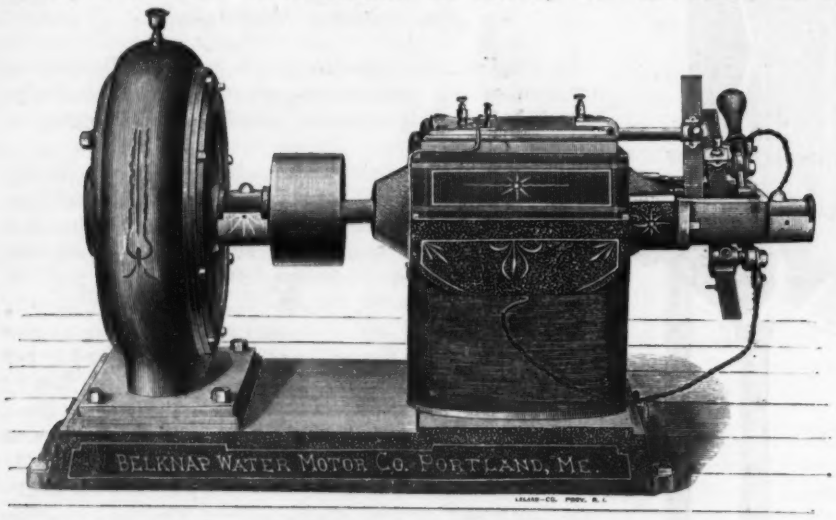
"The theory of the hedgehog form is this: If a closed iron circuit is used, the iron circuit must be long to embrace the copper coils. The only way to shorten it is to make the copper coils smaller. This means using a higher current density which is wasteful, or fewer turns of copper. Fewer turns of copper demands either a higher induction in the iron or a greater cross section, and both of these

mean greater loss by hysteresis. If the iron circuit is opened, the sides of the embracing core can be removed, so the loss by hysteresis is divided by three. As there is now plenty of room for copper, the turns and cross section can be increased, and the iron reduced still farther. The object of introducing the closed iron circuit was to reduce the magnetic resistance. An open circuit transformer has much higher magnetic resistance.

"The construction of these transformers as carried out by Messrs. Swinburne & Company, of Teddington, is very simple. A gun metal casting of cross-shaped section forms the backbone. It is spread out at each end, forming legs at one and taking the circular terminal board at the other. It also carries insulating flanges which form the ends of the coils. Into the four recesses of the core are put four bundles of soft iron wire. These are taped over and the secondary is wound on. The secondary is then covered with two layers of ebonite, and the flanges are also faced with the same material. The primary is then wound on in two compartments separated with ebonite after the manner invented by Gramme, so that both ends come outside, and as far removed from each other as possible. The ends of the core are then spread out and the transformer tested under 4,000 or 5,000 volts; the insulation in megohms being read by a special instrument which measures the effective resistance under an alternating current. As iron cases cannot be used, as they would be magnetized by the transformer, and as any metal would have Foucault currents generated in it, stoneware jars are used for cases. These have lids bolted down, with holes for the leads as shown in the accompanying illustration."

A Water Motor for Small Dynamos.

The accompanying illustration shows a neat and compact arrangement of a small dynamo operated by a water motor which stands upon the same base, and is connected directly to its shaft. These machines are built by the



COMBINED WATER MOTOR AND DYNAMO.

Belknap Water Motor Company, of Portland, Me., and are of three sizes, having a capacity of 10, 20 and 30 incandescent lights of 16 c. p. each respectively. They are intended to be operated on water mains having a pressure of 65 pounds, and at this pressure an armature speed is obtained at full load sufficient to keep the lights at full candle power. For ordinary use the machines are wound for a potential of 50 volts. If the location of the motor is such that the dynamo cannot be connected to its shaft directly, the motor and dynamo are each supplied with a pulley and the two are connected by a belt.

This motor, which is called the "Little Giant," will be found well adapted for service in many localities where current for lighting cannot be obtained from a central station, and where it is not advisable to install a small steam or gas plant to drive a dynamo to furnish current for a few lights.

Quick Work on a Temporary Installation in Berlin.

It is reported from Germany that a large electric lighting plant has been put down almost at a moment's notice for the "Buffalo Bill" show in Berlin, by the firm of Erfurth & Seinell. As the German authorities do not permit of the use of high-tension alternating currents for public shows the Buffalo Bill Wild West Company was obliged to leave its own portable lighting plant in Paris, and subsequently called for bids for the electric lighting of its show (about 60,000 square yards area), in conformity with the very severe rules established by the German authorities for electric lighting. The above-named electrical firm undertook the difficult task to put down the plant according to these rules within eight days. The work was begun on July 19 and was successfully finished in seven days eight and one-half hours. It consists of 150 arc lamps, with reflectors, of 1,500 c. p. each, suspended from high posts, 50 glow lamps of 25 c. p. each and a search-light projector of 45 ampères, together with 20,500 yards of wire and cables and 1,500 insulators. A machine house had to be erected for four boilers of 25 h. p. each and four 200-volt dynamos.

Scott's Flashing Signal Lantern.

The accompanying illustrations show an ingeniously devised lantern by means of which flash signals may be sent on the Morse system with considerable rapidity and under circumstances which have heretofore made it impossible to use the electric light for signaling purposes.

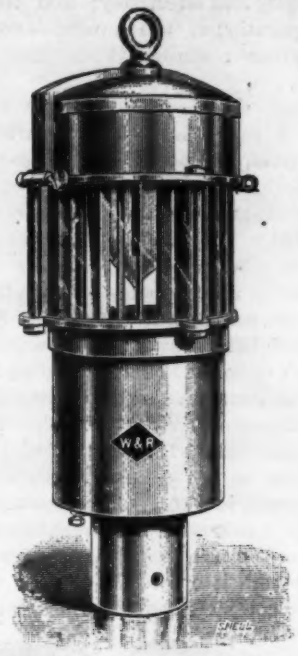


Fig. 1.—Scott's Signal Lantern.

The action of the lantern is said to be very satisfactory. One of the original type has been in use for several months on the "Northumberland."

As will be seen from the illustrations, the lamp is surrounded by a number of vertical shutters pivoted above and below, and engaging by means of short arms or toothed wheels with a central wheel. The motion of the latter is produced by an electro-magnet acting against the force of springs; when the magnet is energized a rapid but short movement of the wheel takes place, opening the shutters for a longer or shorter period as desired, and produces thereby longer or shorter flashes of light. The action of the springs carries the wheel back to its original position as soon as the current is broken in the electro-magnet. The electrical circuits are arranged in a special manner, so that the lamp need not be run at full candle power when the shutters are closed. The magnet coils are put in circuit with the lamp, the resistance of the former acting so as to dull the incandescence, but only to such a point as will allow the thick filament necessary for the 100 c. p. lamp employed to be raised to its full incandescence during the period of the shortest flash which it may be found possible to use in practical working.

The contacts are so arranged that in the act of opening the shutters the lamp and magnet circuits are momentarily in shunt to one another, and as the E. M. F. absorbed by

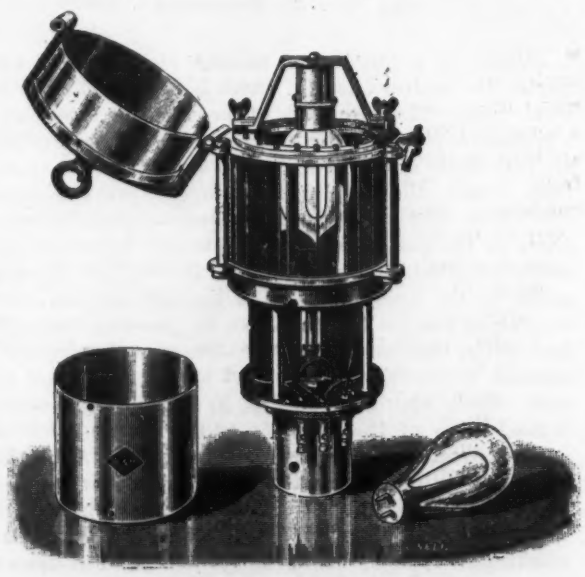


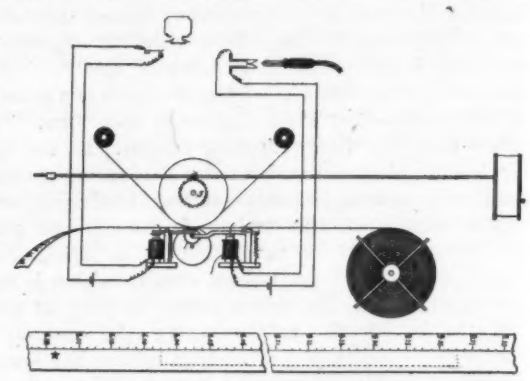
Fig. 2.—Scott's Signal Lantern.

the magnet coils is only eight volts, the amount of sparking during signaling is very small. Extra contacts are added so that if desired a Morse instrument may be used and the signals automatically recorded.

Fig. 1 shows the lantern with its shutters open, and in Fig. 2 the cover and tube have been removed to show the details. By unscrewing the wing nuts *B*, the lamp with its socket *A* may be removed. At *C* are the two magnet coils and at *D* are three terminals, respectively joined to the magnet coils, the lamp and one dynamo terminal. At *E* is a stout tube, by which the lantern may be secured to the top of a mast.

A Registering System for Telephone Exchanges.

With the growth of the long-distance telephone system has come the need of an entirely new set of devices for facilitating work in telephone exchanges. The conditions of long-distance service, both electrically and otherwise, are sufficiently different from those ordinarily met with to demand special apparatus. The device that calls for attention in the present article is one intended more especially to facilitate keeping close account of the business transacted in an exchange, and particularly of the different calls and general service of long-distance lines, where the charges are necessarily high and minutes mean money. It provides means for registering the various circumstances occurring in the routine of exchange service; the number of calls made in the day, the time at which calls are made, the time occupied in connecting, and similar data, are presented in printed form, so that the closest check can be kept on the operation of the lines. The means adopted are comparatively simple. A tape is passed automatically through the apparatus at a known and determined rate and on it are impressed the various characters required to show the nature of the service. The large time wheel, shown in the cut, keeps track of the intervals between the different signals recorded, while these latter are printed by one or more printing levers and wheels thrown into action during the operation of the system; for example, at the moment of calling a star will be automatically impressed upon the ribbon, and when the necessary connection with the station called is made the small dotting wheel shown prints alongside the time scale a row of dots, continuing until the station called is disconnected. The star then locates the moment of call. The interval between the star and the appearance of the dot line shows the time taken to make connections. The length of the dot line determines the exact time during which the telephone was in service by the subscriber. Obviously this form of apparatus can be elaborated to any



Register for Telephone Exchanges.

desired extent, so that, for example, it will be possible to read from the paper ribbon an exact account of the use made of a long-distance line within a day's operation, and when, as is often the case, charges for such service are made on the basis of the time occupied, the use of such an automatic registering device as that here described certainly means a very considerable saving in many cases. It is the invention of Mr. Joel C. Clark, of Morristown, N. J.

An Electric Lamp for Mines.

At a recent meeting of the French Academy of Sciences a full description was presented of an accumulator miners' lamp. The type is known as the Stella lamp, and the description of its operation was received with considerable interest. The lamp weighs 1,600 grammes complete and is of about one c. p. It runs nominally for 12 hours with complete regularity, but its actual lighting power continues effective up to 14 or even 16 hours. Five hours suffices for the recharge, a current of one ampère and four volts being required. The lamp is furnished with an accumulator formed of two little cells of ebonite, each containing five plates three inches long and one and four-fifths inches wide. Two of these are positive plates of solid lead peroxide weighing about 180 grammes and having a capacity of seven ampère hours. The other three plates are of spongy lead. Frequent charge and discharge is found to rather improve the quality of the positive plates up to a certain limit, and there is very little tendency to disintegration. This form of accumulator is found to have little or no local action and to resist shocks very well. The total capacity of the accumulator is 28 watt hours—being seven ampère hours at four volts. For ordinary work in mining the incandescent lamp takes about five ampère hours for 12 hours of lighting. The electrolyte used is of the ordinary sulphuric acid mixture of density, 1.17. The exterior case of the lamp is of galvanized steel, and a space of about 2¼ inches is reserved between this metallic case and the battery itself. This is provided with rubber cushions to avoid injury from shocks. In the face of the exterior box is the lamp and a switch to control it. The form above described seems to be a specially light and simple one, and it has been experimented on with considerable success.

Experiments on the Best Speed for Dynamo-Electric Machines.*

BY M. RECHNIEWSKI.

A good dynamo ought to run regularly, without sparking, should give a good efficiency and ought not to heat dangerously by running for many hours, or even for several days, if necessary. The first two conditions can be fulfilled by careful mechanical construction on the one hand and good electrical designing on the other. Of this I will not speak more for the present. The efficiency depends on a complex series of different phenomena which have been heretofore often discussed. This question of efficiency is directly connected with that of heating, of which I am going to speak more in detail. Indeed, efficiency and heating both depend on the quantity of energy transformed into heat in the interior of the machine. Heating is the foe from which designers have most to fear, and it is the thing above all others which limits its performance of even the best machines. It has often happened, for example, in the laboratory of the Société pour L'Eclairage Electrique, that a dynamo designed for 14,000 watts was forced for an hour up to 22,000 watts, and the machine ran well and did not break down; but the temperature had risen at the end of an hour to 80 degrees. As it takes about two hours for this machine to attain its steady temperature, it was clear that this forced output could not be continued without danger. It has often been proposed to avoid this difficulty by the use of fireproof insulating material. MM. Fritsche and Pichon in Germany, and M. Chertemps, in Paris, have employed this expedient and do not fear any temperature below 200 degrees. Nevertheless, it is somewhat likely that this practice will not become general. It presents too many inconveniences; beside, while it increases the output of the machine, it diminishes the efficiency. The copper increases in resistance on heating, so that the voltage in the machine varies considerably as the temperature rises. The heating reaches the commutator and brushes and renders the care of them more difficult. Fireproof insulating material takes more space than usual, and possesses less endurance from a mechanical standpoint, so that one may often lose more output by the diminution of the useful volume of copper on the armature than is gained by the possibility of running at higher temperatures. I think the maximum temperature which can safely be admitted for the armature is about 70 degrees, say about 40 to 50 degrees above the temperature of the surrounding air. At this point insulating material stands well, and the effect of increased resistance of the copper is little noticeable.

The amount of heating depends on two factors—the amount of energy transformed and the cooling surface. For field magnets the solution is clear enough. About eight square centimetres of cooling surface is required per watt transformed into heat. In the case of the armature the problem is not so simple, for the quantity of heat produced depends on several variables; first, on the current in the wires; second, on Foucault currents in the same wires, in the core and, in general, in all the metallic parts of the armature; third, on hysteresis of the core under the reversals of magnetization. Cooling depends on the linear velocity and on the surface exposed. The task of the constructor is then to determine all these quantities so as to produce the maximum output without passing the safe limit of heating, say 40 degrees above the temperature of the surrounding air.

Let us consider a machine of any construction whatever. The output which can be obtained from it without heating above the prescribed limit will vary with the velocity. There is evidently but one speed for which this output is a maximum, and it is particularly interesting to determine this. Preserving a constant magnetization, the ordinary condition in practice, power P, furnished by a given armature, will be proportionate to its velocity v and to the density δ of the current in the wire.

$$P = \alpha\, v\, \delta.$$

The heating produced by the current is proportionate to the square of the current density. If V is the total volume of copper on the armature and ρ the specific resistance of copper, this will be

$$\rho\, V\, \delta^2.$$

The loss of energy by Foucault currents of every kind is proportionate to the square of the velocity, and can consequently be written

$$\beta\, v^2.$$

Finally, the loss by hysteresis is proportionate to the velocity. Designating by V', the total volume of iron in

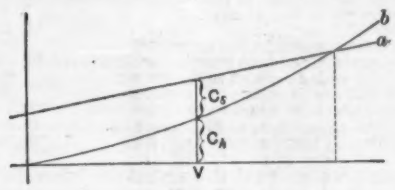


FIG. 1.

the armature, by σ, the loss of energy per cubic centimetre for a complete cycle of magnetization, and by N, the number of reversals per second, we can write for the loss by hysteresis

$$N\, \sigma\, V_1$$

where $N = \gamma\, v$ is proportionate to the velocity. The total loss will then be

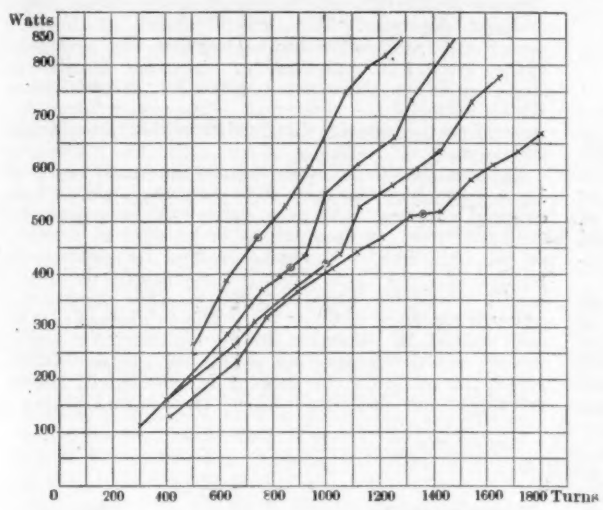
$$\Delta P = \rho\, V\, \delta^2 + \beta v^2 + \gamma\, \sigma\, V_1\, v.$$

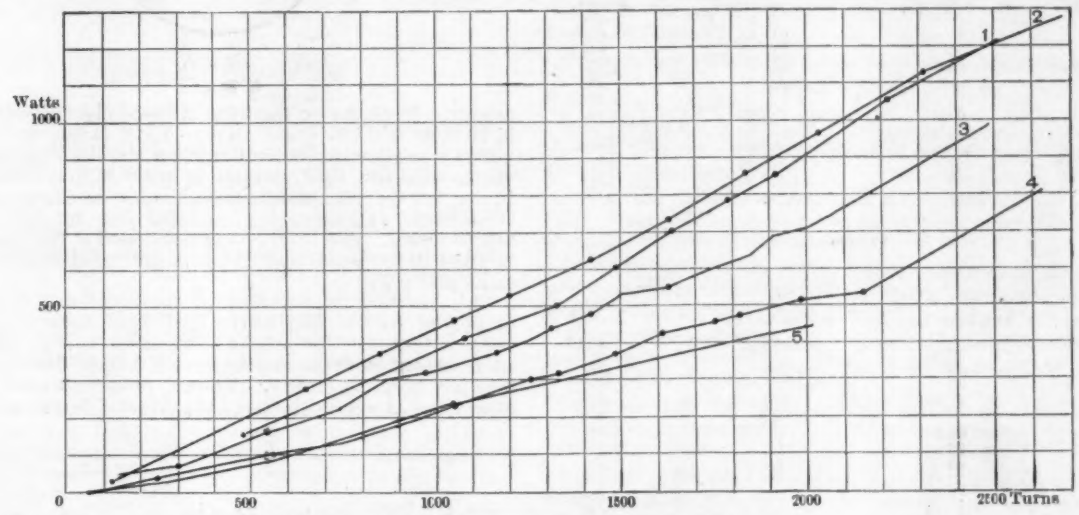
The quantity of heat which the armature loses by radiation in the two cases—and the surface of the armature more than upon its volume. To sum up, the heat C_h developed by hysteresis and parasitic currents would be n^3 times larger; but the cooling will also be n^3 times larger, since it only depends on the surface and peripheral velocity, consequently the total quantity of heat which one can allow to be developed without danger to the armature would be n^3 times greater than before. The quantity of heat C_δ, which can be permitted to be developed in the wire will be also n^3 times greater, which gives

$$\delta' = \frac{\delta}{\sqrt[4]{n}} = \delta n^{\frac{1}{4}}.$$

The ratio of these two quantities of heat remains constant for all similar armatures which have like dimensions on condition that they are run at the same peripheral velocity v. The power P' developed by the large machine will be, as can be simply calculated, $n^{\frac{5}{4}}$ greater than in the small machine, and the heating of the machine in its permanent running condition will be the same. We see then that this first machine gives its maximum power for a certain peripheral velocity V. The large dynamo will furnish its greater power at the same velocity, which was the proposition laid down to be demonstrated.

Let us consider now more in detail the different losses of energy in the armature. The loss by the passage of the current through the wire is inevitable and can be easily calculated. The same is true of the loss of energy in hysteresis, but this is not true for the loss by Foucault currents. By means of careful construction this can be





FIGS. 2 AND 3.—LOSSES IN DYNAMOS RUNNING LIGHT AT VARIOUS SPEEDS.

for a given difference of temperature, 40 degrees, for example, is a function of the form and dimensions of the surface S_r of the armature and of the peripheral velocity v. When the permanent state is reached, this quantity of heat lost must be equal to the heat produced ΔP,

$$\Delta\, t\, f(S_r\, v) = \rho\, V\, \delta^2 + \beta\, v^2 + \gamma\, \sigma\, V_1\, v.$$

It then remains to determine the velocity for the current density δ, so that the output of the machine will be the greatest possible, while the rise in temperature must not exceed 40 degrees. We can represent as a function of the velocity v the quantity of heat which it is possible to develop in the armature without passing the temperature limit of 40 degrees. Let a, Fig. 1, be the curve. The quantity of heat developed in running light, that is to say, simply exciting the machine, taking into account the exterior current, would be represented by a short curve b. The quantity of heat which it is permissible to develop in the wire by the discharge of current is then given for each velocity by the difference of the two ordinates. When the velocity is raised sufficiently there will be a point where the two curves intersect. At this speed hysteresis and parasitic currents alone are sufficient to raise the temperature to 50 degrees. At this speed, consequently, the machine cannot do any exterior work of a permanent sort. There will be, too, a velocity for which this exterior work will be a maximum. Given the two curves a and b, one can find this velocity by calculation, or it can be found experimentally. Let V be this velocity for the machine considered, C_h, C_δ, the heats developed at this point by hysteresis and parasitic currents on the one hand and by the normal currents for the machine on the other. The dynamo is then running at what we may call its best speed. It can be easily proved that when the dimensions of the armature are increased this best rate is constant for a given peripheral velocity V. This velocity does not depend on the form of the armature or upon its dimensions, provided that the armature in changing its dimensions changes them symmetrically.

Consider, for example, a machine of which the dimensions are n times greater than those of the machine for which we have determined the best peripheral speed V, and let us run this large dynamo at this speed. The volume of iron involved is n^3 times greater, but the number of reversals in magnetization will be n times smaller, consequently the heat produced by hysteresis will be n^3 times that in the smaller machine. Los parasitic currents increases almost in the same proportion if the machine is well constructed, for this loss depends on the peripheral velocity, the division of the materials—which is the same diminished very much until it is almost negligible, although the task is not always easy. The loss from this cause in the iron can be reduced to a very small quantity by sufficient care in lamination; but in machines for large output there are similar losses in the wires if they are of large size, or between the different wires of a group if they are joined in multiple arc. These losses can be reduced by composing the windings of a large number of thin wires in parallel and twisting them together before being wound upon the armature. This arrangement, however, is objectionable from the space occupied, for less wire can be put upon the armature than if the individual wires were placed parallel to each other. Toothed armatures are not subject to this difficulty, for the teeth protect the wire placed in the interstices—in other words, all the wires placed in a given slot are submitted at the same time and not successively to the changes in magnetization, and consequently there are no differences of potential produced between them. This constitutes a considerable advantage in using toothed armatures for large machines. The parasitic currents are inconsiderable, as we have shown by placing bars of copper in the slots and turning the armature in a magnetic field.

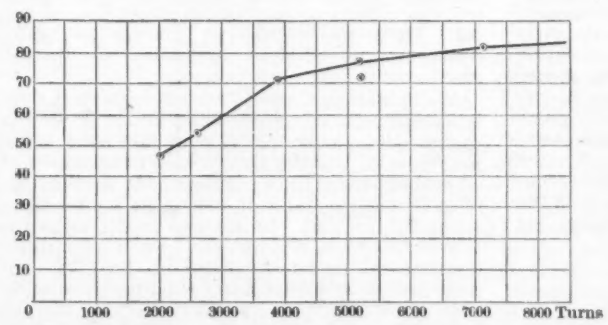


FIG. 4.—CHARACTERISTIC OF A 10 KILOWATT MACHINE.

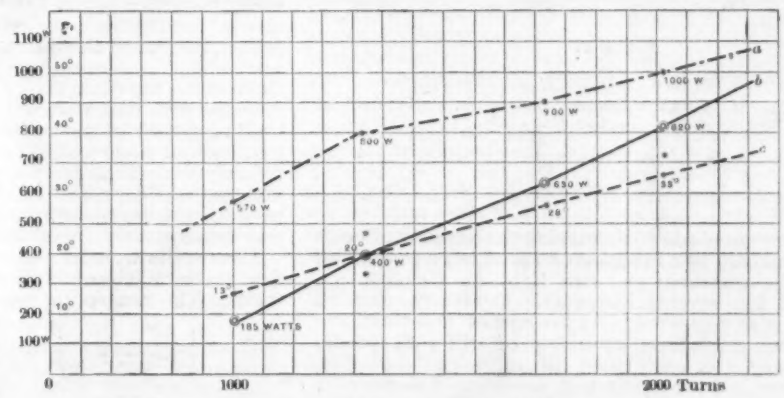


FIG. 5.—ENERGY LOST IN ARMATURES.

The following results were obtained in the laboratory of the Société pour L'Eclairage Electrique. The curves of Fig. 2 represent the losses by hysteresis, Foucault currents and friction in a machine giving 14,000 watts at 110 volts and 127 ampères at 1,250 turns per minute. Circles dotted in the centre show for each current the velocity at which the potential of 100 volts was reached. These curves are obtained in the following way: The armature was run light as a motor for different excitations of the field magnets, and the current and voltage absorbed by the armature were noted at different speeds. The current multiplied by the voltage gives the work absorbed by the armature running empty. Plotting for each excitation of the magnets this work as ordinates and the speeds as abscissæ, we obtain the curves 1, 2, 3 and 4. In making these experiments the purpose was to determine the magnetic field and the speed which would give, for a given frame, first, the best efficiency; second, the greatest output. For this purpose it is necessary to know how losses of a machine vary when either field or velocity are made to vary. Curve 1 gives losses for a field of 7,240; curve 2, 6,000; curve 3, 5,200; curve 4, 3,800, counting as the strength of the field that developed in the pole pieces. We see from the form of the curves that the losses increase in this machine at a rate varying nearly proportional to the velocity; that is to say, the Foucault

* A paper read before the International Society of Electricians.

currents are negligible. The slight curvature of the curve toward its top can be attributed to the mechanical friction of the air, which increases as the square of the velocity. Fig. 3 shows the same curves for a machine giving normally 10,000 watts at 1,400 turns, and for successive excitations of 2,000, 2,600, 3,900, 5,200 and 7,150 ampère turns. Fig. 4 represents the characteristics of this machine. As is evident, the normal field requires an excitation of about 3,900 ampère turns. Tables 1, 2, 3, 4 and 5 are the data from which curves of Fig. 3 were drawn. They show the voltage corresponding to each velocity and to each excitation.

TABLE I.

Magnetizing force, 7,150..... { Current, 2.75 ampères. Number of turns, 2,600.

Current in armature.	E. M. F. at the brushes.	Energy absorbed in the armature.	Number of turns.
5.07	31	157.17	486
6.22	52	323.44	876
6.55	63	412.65	1,074
6.55	76	497.80	1,332
6.87	90	618.30	1,514
7.00	100	700.00	1,630
7.33	107.5	787.97	1,792
7.47	113.5	847.84	1,912
8.02	133	1,066.66	2,288
8.02	150	1,203.00	2,506

TABLE II.

Magnetizing force, 5,200..... { Current, 2 ampères. Number of turns, 2,600.

Current in armature.	E. M. F. at the brushes.	Energy absorbed in the armature.	Number of turns.
3.50	7.00	24.5	116
6.87	39.50	271.36	652
7 75	49	379.75	856
7.75	60	465	1,056
7.75	68	527	1,204
8.00	78.50	628	1,420
8.10	92	745.20	1,624
8.20	105.5	865 10	1,836
8.50	115	977.50	2,036
8.70	132	1,148.40	2,312
8.80	143	1,258.40	2,616
8.80	153	1,346.40	2,812

TABLE III.

Magnetizing force, 3,900..... { Current, 1.5 ampères. Number of turns, 2,600.

Current in armature.	E M. F. at the brushes.	Energy absorbed in the armature.	Number of turns.
3.50	8.50	29 75	120
4.14	16.50	68.31	300
5.40	30	162	544
5.60	39	218.40	740
6.20	47.50	294.50	840
6.50	50	325	972
6.50	59.50	386.75	1,168
6.55	63	412.65	1,256
6.80	66	448.80	1,310
6.80	71	482.80	1,424
7	76	532	1,500
7	78.50	549.50	1,620
7	85	595	1,704
7.30	89.5	658.35	1,852
7.30	95	693.50	1,900
7.30	98	715.40	2,010
8	125	1,000	2.474

TABLE IV.

Magnetizing force, 2,600..... { Current, 1 ampère. Number of turns, 2,600.

Current in armature.	E. M. F. at the brushes.	Energy absorbed in the armature.	Number of turns.
3.00	10.50	31.50	240
4.60	23	105.80	564
5.07	30.50	154.63	792
5.40	42	226.80	1,050
5.90	50	295	1,272
6.00	51.50	309	1,324
6.55	57	373.35	1,480
6.70	65	435.50	1,614
6.70	68	402.40	1,740
6.75	70	472.50	1.808
6.75	72.50	489.37	1,900
6.80	74.50	506.60	1,996
6.80	74.50	506.60	2,000
6.90	77	531.30	2,124
8.02	102	818.04	2,640

TABLE V.

Magnetizing force, 2,000..... { Current, 0.77 ampère. Number of turns, 2,600.

Current in armature.	E. M. F. at the brushes.	Energy absorbed in the armature.	Number of turns.
2.93	10	29.30	276
4.14	22	91.08	548
5.80	40	232	1,068
6.55	65	425.75	1,900
6.80	68	462.40	2,016

The experiments made to determine the amount of cooling in the armature as a function of speed were conducted as follows: The armature was run light as a motor in a constant field for several hours and the temperature of the armature was measured. At the end of this time (the experiment being made at a number of different speeds) one could measure for each speed the number of watts lost in the armature and the amount of heating. The curve *c*, Fig. 5, gives the rise in temperature for the different speeds. From this data could be calculated the number of watts which the armature could radiate at different velocities when its temperature is, say, 40 degrees above that of the surrounding air. The curve *a* in Fig. 5 represents the number of watts for the machine tried as above. Curve *b* represents the number of watts lost by hysteresis and Foucault currents at different speeds but in the normal field. The difference in the ordinates of these two curves represents the number of watts that are lost in the wire of the armature. As is plainly seen, the cooling increases quite rapidly with the speed and must be taken into account.

The curve *a* should be determined for each type of armature, for it furnishes very valuable data for armature construction. It will be seen at once that it is impossible to give a formula for the heating of an armature as a function only of the watts transformed into heat and of the cooling surface. The form and the peripheral velocity of the armature will enter as important factors into this question. It is clear, too, that armatures which are more or less rough on the surface give different results; so much so that this single fact is sufficient to explain certain differences in heating which are observed in winding a given armature in different ways to preserve the same volume of copper and the same current density. The loss in the machine running empty as a motor being known, and the resistance of the wire being known, we can calculate the total loss at full load, and obtain then the commercial efficiency of the machine without direct experiment. I have, however, verified this method directly, as will be seen later.

Calculation of the commercial efficiency of a compound-wound 10,000-watt machine, giving 70 volts and 142 ampères at 1,500 revolutions. Having run the machine at full load for several hours, it reached a steady temperature in every part and was stopped. The temperatures of the armature and of the field coils were then measured and found to be 60 degrees C. for the armature and 35 degrees for the field coils.

The resistance of the armature measured at 20 degrees was	.0109 ohm.
The resistance of the armature calculated at 60 degrees should be	.0126 "
The intensity of the current in the exterior circuit	142.8 ampères.
Intensity of current in the shunt	1.49 "
Total intensity	144.29 "
Electromotive force spent in the armature	1.818 volts.
Total energy transformed into heat in the armature	261.79 watts.
Resistance of the series coils at 20 degrees	.005 ohm.
Resistance of the series coils at 35 degrees	.0053 "
Energy transformed into heat in the series coils	108.1 watts.
Resistance of the shunt coils at 35 degrees	46.98 ohms.
Energy transformed into heat in shunt coils	104 watts.

From table 3 we see that the armature running at 1,500 revolutions and absorbing 76 volts spent 532 watts, running

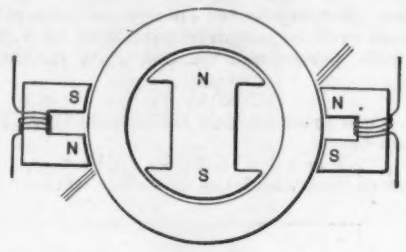
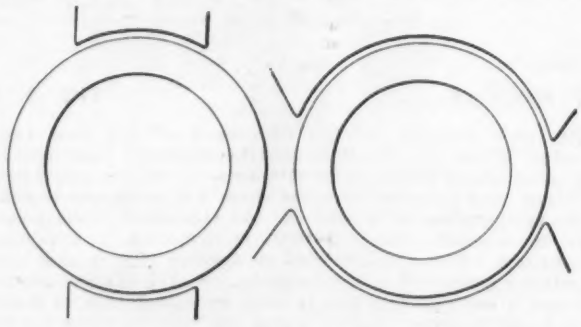


FIG. 8.

empty. In each case the total induced electromotive force is 70 volts + 0.756 (field coils) + 1.818 (armature) = 72.56 volts; consequently, assuming that the loss by hysteresis varies with the field, which is true within quite large limits, for this machine we obtain a loss in the armature of 509.3 watts, and this gives us a total loss at full load of 983.19 watts. The total power developed at full load would be then 10,983 watts and the commercial efficiency is consequently 0.91.

This method of calculating the efficiency which was employed by the jury at the Paris Exposition of 1889 has been criticised. The principal objection is that the losses by Foucault currents and hysteresis will be different at full load and running empty. To take proper account of these objections as applied to large machines, I have verified directly the efficiency of the 10,000-watt machine considered above. For this purpose I coupled two similar machines together, ran one of them as a motor and measured the current and voltage which the other produced run as a generator. Comparing the electrical energy furnished by this second machine with that absorbed by the first, we can calculate the total efficiency of the two similar machines, and, assuming that each of them had the same efficiency, we can obtain directly the efficiency of each. This method seems to me very reasonable, since the electrical quantities can be measured for the two machines through the same instruments, and consequently are entirely comparable.

The results were as follows: The speed was 1,248. The first machine absorbed 73 volts and 128 ampères, or 8,979 watts. The generating machine produced 63.9 volts, 114



FIGS. 6 AND 7.

ampères, or 7,284 watts. The efficiency of the double transformer was then 0.8114 and the commercial efficiency of each machine was 0.901. If the machines had been running at full load the efficiency would have been a trifle higher, and would probably have reached the calculated figure 0.91. In any case it is evident that the difference between the calculated and the experimental result is negligible.

I have made the same experiments with several other types—among these my 5,700-watt machine. The steady temperature of this class of machines is found to be 65 degrees for the armature and 55 degrees for the field magnets. Under these conditions the resistance of the armature at 65 degrees was .059 ohm, the resistance of the series coil .0358 ohm, of the shunt coil and of the rheostats 61 ohms. At full load it gave 110 volts at the terminals, 51.8 ampères on the exterior circuit and on the series coils, 52.6 on the armature and 1.8 on the shunt coils. The losses by heating can then be calculated as previously and amount to 472.366 watts. The loss by hysteresis and Foucault currents at 1,600 turns and the normal field amounted to 307 watts. Total energy lost was then 779.366 watts, which gives an efficiency of 0.88. Two similar machines were then belted together and gave the results shown in Table VI., one acting as a motor and the other as a generator.

It will be seen from this table that the highest efficiency obtained was 0.867, differing consequently by 1.3 per cent. from the calculated efficiency. This difference is quite explicable by the difference in speed of the two machines. For example, the first machine ran at 1,610 turns, the second at 1,574. There were then 36 turns lost by slipping. This difference in speed is more than sufficient to explain the difference between the measured and calculated efficiencies. This last table is quite interesting because it gives the efficiency at different loads. It will be noticed that the efficiency is given through quite wide limits; even running at one-third load it still remains nearly 80 per cent.

TABLE VI.

Receiving Machine.				Driving Machine.				Efficiency.	
E. M. F. at the terminals.	Current.	Speed.	Power furnished.	E. M. F. at the terminals.	Current.	Speed.	Power at the terminals.	Of the whole.	Of each machine.
121.6	60.	1,572	7,296	101.84	53.3	1,554	5,429	0 744	0 862
119.6	60	1,534	7,176	99.5	53.3	1,524	5,292	.737	.858
119.6	60	1,534	7,196	99	53.7	1,504	5,316	.740	.860
126.5	63	1,534	7,969	103.7	54.2	1,648	5,620	.705	.839
123.6	55.7	1,610	6,884	101.8	48.7	1,580	4,955	.719	.848
123.6	52	1,610	6,427	103.2	46.3	1,574	4,778	.752	.867
123.6	50.8	1,654	6,278	104	44	1,620	4,576	.728	.853
123.6	46.3	1,654	5,722	104	40.4	1,610	4,201	.734	.857
123.6	43.4	1,654	5,364	103.7	37 4	1,600	3,878	.722	.850
123.6	40.2	1,654	4,968	103.7	33.7	1,618	3,494	.703	.838
123.6	35 0	1,678	4,326	104.6	28	1,628	2,928	.677	.822
123.6	31.4	1,678	3,881	105	24	1,662	2,520	.649	.805
123.3	27.3	1.666	3,374	105.6	20	1,624	2,112	.625	.791
123.6	24.7	1,744	3,052	106	16.7	1,650	1,770	.665	.815
123.6	10	1 758	1,236	106	....	1,732	.....	.665	.815
123.6	7.2	1,758	839	....	....	1,700	.....	.665	.815

High Power Machines.—We have seen that as the dimensions of machines increase the output increases rather more rapidly than the weight. On the other hand, the diminution in labor in building does not correspond with this increase of weight, because the pieces become harder to manage and are not as conveniently made as the parts of smaller machines. Consequently large machines made on similar patterns with small ones should cost rather more. What, then, is the most economical construction? It is probably reached by modifying the relative dimensions of the pieces. The cooling surface must be increased by interior ventilation or by making the armatures shorter and of larger diameter. These modifications determine a new peripheral speed somewhat higher than the original and a rather greater current density. In other words, for each size of machine there are certain forms and dimensions which will give the best result. These very large dynamos present certain special difficulties which should be carefully noted.

Suppose that the dimensions are increased in the ratio of 1 to n to produce the same field running light, n times the original number of ampère turns will be required on the field magnets; but meanwhile the number of ampère turns on the armature for the same heating increases in the proportion of n^2 to 1, so that for a certain definite size it would equal the ampère turns on field magnets, consequently sparking must ensue. The excitation of the magnets should be increased to compensate for the voltage lost by the demagnetizing action of the armature. The larger the machine the more this effect will make itself felt unless the magnets both as to iron and copper are increased in size. The effect is very marked indeed in shunt-wound machines submitted to considerable variations of load. Before there is time to adjust the excitation to this variation a formidable sparking often injures the commutator. The exterior field is likely, too, to become powerful. These inconveniences increase so seriously that it seems to me almost impossible to construct bi-polar machines of very high power.

Multipolar machines, 500 to 1,000 h. p., do not present these difficulties. From every point of view which comes under our consideration they act as a series of bi-polar machines of smaller size, joined in multiple. The number of ampère turns in the armature is divided by the number of poles so that one can construct multipolar machines as powerful as may be desired with an armature reaction as weak as convenient. Such machines can even be constructed so as to have no lead of brushes. It is only necessary for this to construct them with a considerable number of poles so as to reduce the reaction of the armature and to force the excitation slightly. It is impossible to do this in machines with large poles wound shunt or compound. All these inconveniences of reaction of the armature come from the fact that, to avoid sparking at the brushes, we are obliged to place them in a position where the field produced by the armature is counterbalanced by the field produced by the magnets, which compels us to furnish to the magnet a number of ampère turns greater than the maximum of those which can be produced at any time by the armature. The ampère turns of the armature and the field magnets work then in opposition and neutralize each other. The effect is very noticeable on machines with straight pole pieces (Fig. 6), since the ampère turns of the armature between the pole pieces work directly in opposition to the magnets, although under the pole pieces they only distort the field; they would not even tend to diminish it if certain effects of saturation in the iron did not complicate the phenomena.

But it is possible to employ other methods of stopping sparking at the brushes, and in this case not only the ampère turns in the armature need not necessarily be put in opposition with those of the magnets, but even may help them. Consider the arrangement of Fig. 8. *NS* is the principal electro-magnet which we put in the interior of the ring armature. Two little electro-magnets designed to stop sparking are also shown. We see that in this position the ampère turns of the armature increase or diminish the field. One could then even make a machine without wire upon the magnets. During the past winter I have made some experiments on a machine constructed on the above principle, and the results completely agree with the theory. Mr. Swinburne, one of the cleverest English electricians, has given recently the results of some other experiments for obtaining the same results.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Sept. 6, 1890.

Pacific Coast Agency.—Thomas Day & Co., of 223 Sutter street, San Francisco, Cal., have taken the Pacific Coast agency for the Interior Conduit and Insulation Company, of New York.

Motor Patents Sold.—The Edison General Electric Company has purchased the entire patent rights of the Diehl motor from Messrs. Diehl & Co., of Elizabeth, N. J., and will at once begin the sale of these motors for the purposes to which they are adapted.

The National Conduit Manufacturing Company has just closed a contract for all the underground conduit for the electric street railroad at Buffalo, N. Y. The feeders which supply the current to the railway lines will be placed in these conduits. The Field Engineering Company, of New York, is doing the work of laying the conduit.

Cheaper Electric Lights.—The Edison Electric Illuminating Company, of this city, has given public notice of a reduction in the price for current to one cent per hour for each 16 c. p. lamp, or proportionate charge for lamps of greater power, or for motor service. The company says that the great improvement in its business, and its increased facilities enable it to make this reduction.

Dr. J. B. de Lery is pushing rapidly the work of laying out the streets and avenues of the "electric city" at South Lakewood Park, N. J. The streets will all be given names appropriate to the character of the city, such as Edison avenue, Westinghouse street, Watt street, Ohm avenue, etc. Mr. de Lery has secured the services of Mr. Geo. D. Stonestreet, who laid out the town of Birmingham, Ala., to locate the streets of this new town.

The friends of Mr. J. P. McQuaide will sympathize with him in the loss which he has sustained by the death of his mother. Mrs. McQuaide was well known to a large number of the electrical fraternity, many of whom made her acquaintance at the various electric light and telephone conventions which she has attended with her son. She was taken sick while attending the telephone convention a year ago and has never recovered. She died at Cape May Point, N. J., on Tuesday, Sept. 2.

Mr. R. H. Sherwood, of the railway department of the Thomson-Houston Electric Company, at 115 Broadway, this city, has just closed the contract with the Flushing & College Point Street Railroad for four miles of track and five cars to be fitted with 30 h. p. double motor trucks. The cars are furnished by the John Stephenson Company. The contract includes also a complete station equipment. Mr. Howard Wheeler, formerly of the railway department of the same company at the Boston office, but who has for some time been associated with Mr. Sherwood in the management of the New York office, reports that the company is extremely busy in caring for its railway business.

An Electric Boat.—Mr. Frank A. Perret, electrician of the Elektron Manufacturing Company, of Brooklyn, well known as the inventor of the Perret motors and dynamos, has just completed a new electric boat. At a recent trial six cells of ordinary cautery battery of his own construction ran the boat very successfully. The boat is described as being lightly constructed, of canoe shape, and capable of carrying two persons. The motor used is built to run at 10 volts and to take 40 ampères of current. Paddle wheels are used which feather the water automatically, the paddles being in an upright position and never turning over as they would in the old style of paddle wheel. In the test made the power was transmitted from the motor to the paddle wheel shaft by a single round belt, and the battery is said to have furnished enough power to cause the belt to slip. The solution used in the battery is composed of chromic acid and sea water. The test was considered a very successful one. W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 8, Cook Building, cor. Franklin and Congress Sts.
BOSTON, Sept. 6, 1890.

The T. M. Foote Regulator Company is moving into new and handsome offices at 271 Franklin Street.

The New England Printing Telegraph Company has completed its line from Providence to Woonsocket, and is rapidly pushing through to Boston.

The Thomson-Houston International Electric Company is installing an arc and incandescent plant at Georgetown Demerara and is fitting it with a 100 h. p. McIntosh & Seymour engine.

H. W. Leach & Co., report the construction of the foundation mason and brick work for one 300 h. p. McIntosh and Seymour engine with Kendall & Sons boilers, for the Citizens' Gas Light Company, Wakefield, Mass.

The Van Depoele International Company, with a capital of $100,000, has been incorporated for the purpose of manufacturing reciprocating engines and motors. Mr. George W. Davenport, Boston, is president, and Mr. Demaso Mazend, Boston, treasurer.

A Correction.—The Eastern Electrical Supply and Construction Company has leased very fine stores at 65 Oliver street, and will open for business on Monday. This is a correction from our last issue, in which we noted that they were to locate at 74 Federal street.

Mr. Chas. L. Tolles, representing the Jewell Belting Com. pany, is about to close the company's office in Lynn which was opened temporarily at the time of the big fire. The company has been very successful in the sale of belting in this section of the country.

Additions to Its Factory.—The Woonsocket Gas and Electric Company is making an extensive addition to its equipment, enlarging its steam plant by the addition of a 100 h. p. high speed engine and a new boiler. It is also adding a 500-light alternator of the Brush pattern.

Newport, R. I.—The Edison Illuminating Company has elected the following officers: Directors, F. W. Vanderbilt, T. M. Seabury, L. L. Lorillard, A. C. Titus, F. H. Hastings, Benjamin Easton, Jr., D. E. Young, John P. Sanborn; secretary and treasurer, John Whipple.

The Westinghouse Electric and Manufacturing Company, through Mr. Barnes, reports the installation of one 750-light alternator to the Milford Electric Light Company, Milford, N. H.; a 150-light direct to the Kendall Manufacturing Company, Providence, R. I., for an isolated plant; a 200-light direct isolated to Hathaway, Soule & Harrington, for their shoe factory at Middleboro, Mass.

The H. E. Swift & Co. Corporation has been formed, capital $50,000, with the following officers: H. E. Swift, president; D. A. Andrews, Jr., vice-president; W. L. Boyden, treasurer; T. P. Swift, secretary. Owing to the pressure of business it was found necessary to increase their facilities, and very important additions will be made at once that will give them one of the best equipped factories in New England.

The Connecticut Motor Company, of Plantsville, Conn., has just concluded arrangements whereby Mr. F. O. Rusling is to become its special agent. Until recently Mr. Rusling has been connected with the construction department of the Thomson-Houston Company, and his many electrical friends may be congratulated upon a change which will enable them to see him oftener in the future than they have in the past.

Rockland, Mass.—The sentiment in favor of an electric street railway at Rockland is growing, and the business men feel assured that with it established the business prospects of the town will be greatly increased. The first meeting of those interested in such a project will be soon called and a company formed. As soon as a charter has been obtained the work of obtaining the necessary $100,000 will be commenced. The part of the road first built will be from Hanover to Rockland, and from thence to South Weymouth and Abington.

The Woonsocket (R. I.) Electric Machine and Power Company has just completed the wiring of the four cotton mills of the Ray Manufacturing Company. The mills are over two miles from the central station. The company reports that it has more orders for private residence installations than ever before. All the installations which it is now making have concealed wiring, making use of the conduit system of the Interior Conduit and Insulation Company. The meter system is used in all new contracts and is said to give much better satisfaction to the company and to the consumer than the contract system. L. H. H.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY BUILDING, PHILADELPHIA, SEPT. 6, 1890.

The Main Belting Company has just completed a 10-ply driving belt 48 inches wide and 150 feet long.

Sunbury, Pa. The Fort Wayne Electric Company is putting in a 50 arc light plant in Sunbury for lighting the streets.

The Cobb Vulcanite Wire Company, of Wilmington, Del., is laying 140,000 feet of its No. 4 Vulcanite wire on Chestnut and Ninth streets, this city, for the Brush Electric Company.

The Fort Wayne Electric Company, through its agent Mr. Wilbur, has sold a 1,000-light Slattery incandescent plant to the Merchant's Electric Light Company of North Front Street, Philadelphia.

Mr. H. A. Cleverly has returned from his recent outing looking hale and hearty and is pushing business with renewed vigor. He has several large contracts for electrical specialties, such as air meters, bells, electric protectors etc., from various parts of the country.

New Philadelphia Company—The Electrical Engineering Company, of this city, has been incorporated, with a capital of $1,000,000, to construct electric railways, cars, etc. The incorporators are Harvey Barton, Henry Gianella, Christopher Schneider and Thomas Marion, of Philadelphia, and Chas. Richter, of Camden.

New Boilers.—We are informed that the Abendroth & Root Manufacturing Company, 28 Cliff street, New York, has just received an order from the Edison Electric Light Company, of Philadelphia, Pa., for 1,000 h. p. Root boilers in addition to the large number of the company's boilers already installed in this well-known electric light station.

Messrs. W. S. Griffith & Co., representing the Mather Electric Company, are now installing a 1,600-light plant for Messrs. Woodward & Lathrop, Washington, D. C. This will be the largest isolated plant in the city, and is to be constructed in the most approved manner. The work is said to have been accepted on the merits of the apparatus alone. The Mather, Thomson-Houston and Westinghouse companies were the only ones allowed to bid on the work.

New Installations.—The Thomson-Houston Electric Company is making the following installations in this and other sections of the country: Oak Lane, Pa., 1,300 incandescent lights for Cheltenham Electric Light Company; Kittanning, Pa., 650 incandescent lights for Kittanning Electric Light Company; Monterey, Mexico, 70 arc and 1,300 incandescent lights for the Monterey Electric Light and Water Power Company, one dynamo, with lamps and supplies being sent by express in order to have lights in operation at the time agreed upon; Wilmington, Del., 150 incandescent lights for George W. Stone; Baltimore, Md., 30 arc lights, together with electric car for Baltimore Sugar Refining Company. The Thomson-Houston Company is lighting the Pittsburgh Exposition Building, which opens Sept. 10. Arc and incandescent lights, together with focusing lamps of 4,000 c. p. will be used.

An Elegant Hotel.—Contracts have been let to Philadelphia parties covering the Kenilworth Inn at Biltmore, near Asheville, N. C., where Vanderbilt is expending a small fortune on a palatial residence situated in the midst of a park of 6,000 acres. It is located at the junction of the Swanannoa and French Broad rivers, embracing beautiful meadow land, as well as rising foot hills, and extending back to the Elk Mountains. The plans for the hotel were made by F. L. and W. L. Price, architects. The ventilation and heating will be very complete and in accord with the most advanced state of the art. Three separate fans driven by independent engines will be used for distributing heated air throughout the entire building, arranged to vary the volume as indicated by the weather. Fast moving hydraulic elevators are provided, as also electric lights for the buildings and grounds. The boilers and steam plant were designed by the Steam Engineering Company, 704 Arch street, Philadelphia, Pa. W. F. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 The Rookery, Chicago, Sept. 6, 1890.

Franklin, Ind.—The Franklin Water, Light and Power Company has been incorporated with a capital stock of $100,000.

Mr. J. D. Robinson, representing the W. L. Libbey & Son Company, of Toledo, Ohio, has been a welcome visitor in Chicago during the past week, and has secured several handsome orders for glassware from the electrical supply companies.

A New Company.—The Chicago & Jefferson Urban Transit Company, Chicago, has been incorporated to build and operate lines of street railway in the city of Chicago and neighboring towns, to be run by electricity or other motive power; capital stock, $1,000,000; incorporators, John Johnson, Jr., Henry Vanetta, Frank H. Dickey, Frank E. Baker, Thomas P. Keefe, Charles P. Hosmer, and Edward D. Hosmer.

Mr. Fred W. Horne, of the Thomson-Houston Railway Department, is being congratulated by his friends on securing the contract for the Davenport, Rock Island & Moline Electric Railroad. This contract amounts to over $300,000 and is one of the largest that has been let in Chicago. The Central Electric Company has secured the order for supplies on this contract. This is probably the largest electrical supply order ever placed in this city, among to upwards of $40,000.

The electrical display at the Sioux City (Ia.) Corn Palace will be one of its leading features this year. Many attractive exhibits are already secured. Electric current will be furnished to exhibitors from batteries, or from 100 or 500 volt constant potential lines or from 50-volt alternating or 10-ampère constant current circuits. The finest location on the ground floor has been set apart for electrical displays. Any one wishing information concerning the electrical department can secure it by addressing the Sioux City Electric Supply Company, at Sioux City, Ia. F. DE L.

SOUTHERN NOTES.

NORFOLK, Va., Sept. 5, 1890.

Florence, S. C.—Parties are talking of organizing a company to establish an electric light plant.

Hopkinsville, Ky.—The city council has decided to establish an electric light plant for street illumination.

On a Visit to Atlanta.—Mr. Fred Andrews, electrician of the Postal Telegraph Cable Company, and Mrs. Andrews are on a visit to Atlanta.

A number of propositions have been made to the town council of Waynesboro, Va., looking to the establishment of an electric light plant.

Hester, N. C.—Capitalists from New York have organized a company to build a new town, and contemplate the establishment of an electric light plant.

New Orleans, La.—Parties are organizing the Consumers Electric Light Company, and have asked the city for a franchise to build an electric light plant.

Basic City, Va.—The Land and Improvement Company has about concluded negotiations for the establishment of an electric light plant for street illumination.

Anderson, S. C.—The newly organized electric light company has gone to work vigorously and has strung most of its wires. The system will be an incandescent one.

Water Valley, Miss.—An election is called for the 29th instant, to vote on issuing $10,000 of bonds for the purpose of establishing an electric light plant.

Portsmouth, Va.—A force of linemen are at work for the Portsmouth Gas Company, which is erecting electric light poles with arms that will swing the light out in the street.

Milledgeville, Ga.—The new dynamo, steam engine and boiler for increasing the capacity of the Milledgeville Electric Light Company have been received and are now being placed in position. It is claimed that when these additions are made Milledgeville will be one of the best lighted cities in the South—population considered.

Getting Out of the Old Rut.—It is stated that the City Council of Augusta, Ga., is considering the matter of ordering electric lights turned on every night regardless of the moon. Up to the present time there have been no street lights on moonlight nights, and the failure of the moon to conform to almanac schedule often left the city in darkness.

During the midsummer festival at Atlanta, Ga., recently, one of the leading features of the occasion was a trade procession in which the Thomson-Houston Electric Company had a float which attracted considerable attention. It was 12 feet long and 12 feet high, and was finely decorated, and beautifully painted. It represented the company's electric light and power plants, and electric railroad system.

Charleston, S. C.—There has been for a good while considerable talk of the different city railways changing their lines into electric roads, but up to date nothing definite has been done in the matter. The officers of the different lines have investigated the matter extensively and are well pleased with the system, but the matter of cost, together with other considerations, have deterred them so far from making the change.

Macon, Ga.—The Home Electric Railway Company was chartered during the past week by the Secretary of State. The incorporators are: J. F. Heard, Jr., David J. Baer, W. E. Jenkins, W. A. Doody, W. A. Lofton, A. C. Knapp, Peter Harris and Michael Dody. The line is to be about four miles long, running from Macon to some point on the Houston County line, at or near Maxwell's Bridge, over the Ichiconnee Creek. The capital stock is $25,000, with the privilege of increasing it to $100,000. Y. N. B.

News of the Week.

THE TELEGRAPH.

Telegraph Company's Property Sold.—The entire property of the Bankers' and Merchants' Telegraph Company, of New York, was sold last week for $390,000, under a judgment of foreclosure.

To Use the Typewriter.—The Associated Press has given instructions to its telegraph operators to learn the manipulation of the typewriter, as it is found that this instrument materially increases the speed of receiving messages.

A New Company.—The Washington District Telegraph Company has been incorporated at Seattle, Wash. The incorporators are A. T. McCargar, E. A. Strout, and R. B. Albertson, of Seattle. The object of the corporation is to construct and maintain a district telegraph system, and its capital stock is $30,000.

New York Ticker Service.—The stock quotation tickers controlled by the stock exchange have been placed in the Western Union Building at No. 16 Broad street, New York City, where heretofore no instruments but those of the Western Union Company have been. This will enable the Gold and Stock telegraph, which s owned by the Western Union, to distribute quotations to out siders after they have been received by members of the exchange.

Company Officers Chosen.—The annual meeting of the New England Printing Telegraph Company was held at the executive office of the company, 113 Devonshire street, Boston, last week. The following board of directors was elected: Frank B. Dole, Boston; John R. Reed, Westfield; P. S. Jennings, New York; Abner McKinley, New York; James P. Cook, Boston; George W. Slade, Fall River; Maybin W. Brown, Boston. Frank B. Dole was elected president; R. H. Waters, treasurer; H. B. Humphrey, secretary; Maybin W. Brown, general manager; C. F. Hutchinson, general supe

tendent. Executive committee: F. B. Dole, Abner McKinley, James P. Cook, George W. Slade.

THE TELEPHONE.

Indianapolis.—The building occupied by the Telephone Exchange was damaged by fire recently to the extent of $1,500.

Malden, Mass.—The Pulsion Telephone Company has been granted permission to extend its lines through several stre ets.

Extension in New England.—The Southern New England Telephone Company is extending its lines in Bridgeport, Conn.

Increase of Subscribers.—The Erie Telephone Company's sub-divisions made a net gain of 50 subscribers in July, and a gain in net earnings of $5,500 over the same month last year.

Beverly, Mass.—The New England Telephone and Telegraph Company is placing a cable 240 feet long, with a capacity for 300 wires, under the water at the Beverly draw bridge. There are three sections to the cable, each containing 100 wires.

A New Line in Indiana.—The Union Central Telephone Company has been granted right of way to construct a line through Goshen county, Ind., provided there shall be free service for county business between Elkhart and Goshen and the county asylum.

To Wear Uniforms.—A recent warrant of the Emperor of Germany orders that the ladies of the Administration of Posts, Telegraphs and Telephones shall be clad in a special uniform. Henceforth these ladies must wear a knitted blue jersey with orange yellow collar, with metal buttons and ornaments.

An Order Vetoed.—Mayor Hart, of Boston, has vetoed the aldermanic order authorizing the appointment of one or more superintendents of the underground work now being done by the New England Telephone Company. It was stipulated that the salaries should be paid by the telephone company.

Allegheny City, Pa., is to have a new police telephone system in the near future. At present considerable trouble is caused by induction from the electric light and street railway wires. The intention is to redistrict the city, put in new patrol boxes and new insulated copper fire alarm and police wires.

Bids Wanted.—Sealed bids will be received at the office of the Bear Valley Land and Water Company, in Redlands, Cal., for the building of a telephone line from Redlands to the Bear Valley dam. Bids to be opened at the office of the company on Tuesday, Sept. 16, 1890, at 2 P. M. John G. North is the general manager.

Long Distance Lines in Europe.—A French company has just obtained a concession from the Russian Government for the setting up of a telephone between St. Petersburg, Moscow, Warsaw and Berlin. The charge for using this telephone is to be two roubles the first minute, and a rouble for every minute after.

To Regulate Charges.—An ordinance has lately been introduced in the city council of Tacoma, Wash., regulating the charges of the Sunset Telegraph-Telephone Company. The ordinance provides that the charge for the use of the telephone instrument shall not exceed $4 per month, and that there shall be no charge for putting up or removing the instruments.

The New England Telephone Company is building a 10-wire copper line from Boston to Fitchburg, a distance of 50 miles, passing through the following towns: Brighton, Watertown, Waltham, Concord (Mass.) and Ayer Junction The poles will be 50, 40 and 35 feet high. The company will open a new office in Lynn about Oct. 1, replacing its office burned in the late fire. It will also open a new exchange in Brighton about Nov. 15 with 50 subscribers, all on metallic circuits.

Telephones in Chinatown.—The last number of the *News Letter*, issued by the secretary of the National Telephone Exchange Association, says that a few weeks since Superintendent Jacoby, of the Pacific Telephone and Telegraph Company noticed that there was a considerable falling off in orders for telephones from Chinatown. This in itself was not a suspicious circumstance, but when a number of Chinese firms, who for years had rented telephones from the company, sent in instruments, with the explanation that they were no longer required, the suspicions of the official were aroused, and upon investigation it was found that the wily heathen had organized a company of their own, and decided to pay no more rent or "call" fees to the regular company. They had bought up a lot of second-hand instruments from electrical companies and were running wires over the house tops independent of those of the company. The work had all been done by Chinese, and so skillfully had the scheme been manipulated that they were not detected. They had no central office, and how long the system had been in operation is unknown. Fifteen sets of instruments were confiscated and at once removed to the office of the Pacific Telephone Company. The wires connected all the principal stores in Chinatown, lodging-houses, offices of the six companies, warehouse, steamship offices and docks.

THE ELECTRIC LIGHT.

Princeton, Ind., is to be lighted by electric lights.

Yazoo City, Miss.—Work will begin at once on the electric light plant.

Cohasset, Mass.—The new electric light station is to be opened on Sept. 15th.

Portland, Me.—The Orient Electric Company will establish an electric light plant.

Charleston, S. C.—The Electric Light Company is improving its plant by the addition of a new dynamo.

Portage, Man.—The Central Electric Light Company has been organized to establish an electric light plant.

Rockport, Tex.—Messrs. Barlow & McCoy have made the city a proposition to erect an electric-light plant.

Spencer, Ind., has adopted the Schuyler system of arc lighting, and the company is now installing a 50-light apparatus.

El Paso, Tex.—The El Paso Gas, Electric Light and Power Company has the contract to light the city for five years.

Butler, Pa.—An Edison plant of two No. 10 compound wound dynamos will be installed to furnish incandescent lights.

Belfast, Me.—The Belfast Electric Light Company has been awarded the contract for lighting the streets with electricity.

Chattanooga, Tenn.—The Farrell Electric Light, Heat and Steam Company has been incorporated. J. A. Hart is interested.

Bismarck, N. D.—The Thomson-Houston Electric Company has been awarded the contract for lighting the streets by electricity.

Boonville, N. Y.—The Electric Light and Power Company, of Boonville, N. Y., is putting in a new dynamo for incandescent lighting.

Helena, Mont.—The Helena Electric Company will erect a new building, 176 × 120. The walls are to be of stone, 18 feet high and 2 feet thick.

Milford, N. H.—A new central station plant of 500 lights capacity of the Westinghouse alternate current incandescent system is now being installed.

Waynesboro, Ga.—The Waynesboro Electric Light Company has been organized with a capital stock of $7,500. The incorporators are A. G. Whitehead, P. L. Corker and others.

Rutland, Vt.—The Rutland Electric Light Company has placed in its station an automatic switch by which, in case of an accident or break to a wire on any circuit, the current is interrupted.

Momence, Il .—The Momence Electric Light Company has been incorporated to furnish light to the city and individuals; capital stock, $3,000; incorporators, I. C. Riker and L. W. Calkins.

Hornellsville, N. Y.—The Steuben Electric Manufacturing Company has been incorporated with a capital stock of $30,000. Incorporators—Charles Adsit, Geo. A. Bronson and James G. Long.

Monroe, Mich.—The Schuyler Electric Company has received the contract for furnishing a 200-arc light plant for the city of Monroe, Mich., and is now at work on the installation of the plant.

Joplin and Carthage, Mo.—The Westinghouse Electric and Manufacturing Company is adding two new central station plants in these two Missouri towns. The plants each have a capacity of 500 lights.

Burlington, Vt.—The electric light company has about completed the foundation for a new 1,300 incandescent light dynamo. This with the present plant will give it a capacity of 2,600 incandescent and 100 arc lights.

Temple, Tex.—The Temple Electric Light Company has received a franchise to erect an electric-light plant, and has awarded the contract to the Heisler Electric Light Company, of St. Louis, for a 1,000-light incandescent plant.

Marquette, Mich.—The city is increasing the capacity of its central station plant of electric lighting. The Westinghouse Electric and Manufacturing Company has been awarded the contract for alternating current apparatus for a 1,500-light plant.

Santa Cruz, Cal.—The Santa Cruz Electric Light and Power Company has contracted for a storage battery to cost $11,000, exclusive of wire, to be delivered by the 1st of October next. The battery will be used both for power and lighting purposes.

Philadelphia, Pa.—The Kennedy-Groswith Electric Light Company has been organized, with a capital stock of $1,000,000. The company will manufacture all kinds of electrical goods. The principal stockholders are Chas. W. Kennedy and Henry Groswith.

Peabody, Mass.—It is reported that the Franklin Electric Light Company will remove its plant from Peabody to Worcester, Mass., and sufficient capital has already been subscribed in the latter city to induce the company to remove there, where it will enlarge its plant.

Seattle, Wash.—The Seattle Gas and Electric Light Company has been incorporated, with a capital stock of $600,000. Incorporators: Dexter Horton, A. A. Denny and John Collins. The objects of the corporation are to establish and maintain gas and electric light plants in Seattle.

The Home Electric Company has been incorporated at Seattle, Wash., with a capital stock of $500,000. The incorporators are C. P. Stone, Isaac Dobson, E. C. Kilbourne, D B. Denton, A. C. Balch and A. Mackintosh. The object is to engage in the electric light and power business.

New Haven, Conn.—Suit has been entered against the New Haven Electric Light Company by Dr. Sanford and Mrs. Margaret Mansfield, who claim $20,000 damages, alleged to have been caused by the jar from the machinery and distribution of soot from the company's central station.

Manchester, N. H.—The new 500 h. p. compound tandem engine, built for the Electric Light Company by the Pennsylvania Iron Works of Philadelphia, has been received. The fly-wheel of the machine weighs 24 tons and is 18 feet in diameter. The engine will be set up ready for operation inside of a month.

Buckhannon, W. Va.—G. M. Fleming is president, and B. D. Bailey, secretary, of the Buckhannon Electric Light Company mentioned last week. The company has let the contract for the erection of its electric light plant to the Edison General Electric Company, of Pittsburgh, Pa. The capital stock is $7,000.

Pittsfield, Mass.—The new Electric Light and Power Company has purchased a lot, on the side of which will be erected the new station, to contain dynamos for light and power and a steam-heating establishment. The main building will be 60x90 feet, and will be two stories, of brick. The boiler-house will be one story, 60x40 feet, of brick.

The East End Electric Light Company, of Pittsburgh, Pa., has been in quest of cheap fuel. It has been using natural gas, which costs too much. A well has been bored to the extent of 2,500 feet, but neither gas nor oil has been found. The company is obliged to give up the search, which has necessitated the expenditure of a snug sum of money.

Birmingham, Pa.—The Consolidated Electric Light Company has been incorporated with a capital stock of $500, with the privilege of increasing the stock to $500,000, to manufacture and sell electrica power and appliances; also, to make and sell gas for heating and lighting purposes. The incorporators are: J. F. B. Jackson, Robert Jemison, R. M. Mulford, Leigh Carroll and J. H. Little.

The Seattle General Electric Company, of Seattle, Wash., held a meeting last week and elected the following officers: President, J. H. McGraw; vice-president, J. M. Frank; secretary, Frank Dimock; treasurer and general manager, T. H. Tyndale; superintendent, James A. McWilliams; directors, J. H. McGraw, T. H. Tyndale, J. M. Frink, I. A. Nadeau and James A. McWilliams.

Southern Installations.—Among the recent installations made by the Schuyler Electric Company in Southern cities are: an 80-light plant at Spartanburg, S. C.; a 30-light plant at Blacksburg, S C.; a 50-light plant at Bedford City, Va.; and a 50-light plant at Buena Vista, Va., together with a 500-light alternator. The Company reports business very brisk in all lines, the factory being overcrowded with work.

The Manchester, (N. H.) Electric Light Company is putting in a large steam engine of the Greene pattern, to furnish power needed in the building. The engine is 500-h. p., and will be used to run the dynamos by means of a line of shafting running lengthwise through the building. The machines will be belted to this shaft. The addition of this engine was rendered necessary by the increasing business of the company.

New Contracts.—The National Electric Manufacturing Company, of Eau Claire, Wis., has just closed contracts, through Mr. L. N. Cox, its agent at Washington, D. C., for electric light plants at the Hotel "Arno," Washington, D. C., at the Globe Cotton Mills, Rock Hill, S. C., and at the cotton mill of the Chester Manufacturing Company, Chester, S. C. Arrangements have also been made with some Philadelphia parties to form a company to build and operate electric light plants and street railways.

Colorado Mineral Palace Plant.—Bids were opened Saturday, Aug. 30, by the Building Committee of the Mineral Palace Company, at Pueblo, Colorado, for a complete incandescent lighting plant of 2,000 lights. The specifications called for the following plant, delivered and installed in the Mineral Palace Building: Four 500-light incandescent dynamos, with base frames, extra armatures, voltmeters, ammeters, switchboard, 2,000 lamps of three different colors, sockets and all necessary wiring to operate 2,000 lights of 16 c. p. each. The wiring to be in accordance with the requirements of the New York Board of Fire Underwriters, Kerite wire to be used, and all fittings, cut-outs, switches, etc., to have porcelain bases. The following bids were opened: Eckemeyer Company, $11,150; Edison Company, $11,200; Ft. Wayne Electric Company, $12,400; Western Electric Company, $13,600. All bids were "pigeon holed" by the Building Committee. The specifications will be revised, and new bids will be called for.

APPLICATIONS OF POWER.

Covington, Ga.—The construction of an electrical railroad to Porterdale is proposed.

Americus, Ga.—The building of an electric railway to Andersonville, a distance of 10 miles, is proposed.

Richmond, Va.—An electric street railroad is to be built across the river by the North Side Land Company.

New Railway Company.—The Pacific Wenstrom Electric Railway Company has been formed in San Francisco, Cal.

Rockport, Tex.—The town council has been petitioned by parties for a franchise to construct an electric street railway.

Richmond, Va.—The Richmond Railway and Electric Company has petitioned the city council for right of way to extend its tracks.

Denison, Texas.—The city council has granted a charter to W. B. Munson, Edward Perry and others to build an electric street railroad.

Roanoke, Va.—The Roanoke Street Railway Company will, it is said, build a quarter of a mile of road as an experiment, operating it by electricity.

Hagerstown, Md.—The Hagerstown Land and Improvement Company has petitioned the town council for a franchise to construct an electric railway.

Knoxville, Tenn.—H. G. Bishop is reported as surveying for a route for an electric railroad to be built from Knoxville to Fountain Head by Boston (Mass.) capitalists.

New Orleans, La.—It is reported that the Carrollton Railroad Company has arranged with the Edison Electric Company for an experimental electrical line to run to Carrollton.

Rutland, Vt.—A 30 h. p. motor of the C. & C. type has been placed in the works of the Vermont School Seat Company to operate its machinery. It runs at a speed of 950 revolutions per minute.

New Company Organized.—The Lebanon & Annville Electric Street Railway Company, of Lebanon, Pa., was organized Sept. 3, 1890, to build eight miles of track. Capital, $50,000. E. H. Brooks is interested.

Lynn, Mass.—The Lynn & Boston Railroad has been granted permission to equip its lines for electric cars on Empire, Timson, Essex, Chatham streets, and Ireson avenue, in East Lynn, nd Summer, Cottage and Boston streets, in West Lynn, to the Saugus line.

Opposition Ended.—The Sacramento (Cal.) trustees recently inspected the electric railroad in San José, and found it working so perfectly that all opposition to granting a franchise for an overhead system was ended. Sacramento will doubtless soon have an electric road in operation.

Electric Railway in Sweden.—An electric railway is to be constructed at Boxholme, Sweden. It is intended for the conveyance of manufactured articles from the iron works to the storehouses. The motive power is a 50 h. p. turbine, working two Wenstrom dynamos. This railway is, we believe, the first of its kind in Sweden.

Aurora, Ill.—Ground was bro ken on the 29th ult., for Aurora's new electric railway, and the company expects to have 12 miles of road in operation by Dec. 1, and 20 miles inside of two years. The Sprague system will be used. The west side of the city, made up largely of retired farmers, is vigorously opposing the road, while their brethren on the east and largest side are circulating petitions for the road on their respective streets.

Visitors at Pittsburgh, Pa.—Messrs. W. L. Elkins, P. A. B. Widener, W. H. Kemble, I. C. Kemble, Geo. D. Widener and J. A. Huhn, of Philadelphia, and J. D. Crummins and Harry Thompson, of New York, all more or less interested in the Pittsburgh Traction Company, were visitors to Pittsburgh last week. The gentlemen were in the city to attend the meeting of directors of the Traction Company. At this meeting, among other business, there came up the question of a three-cent fare, and the company announces that in due season the fare will be reduced to three cents. There is no intention to sell out to the Duquesne Traction Company.

The New York Street Railway Association.—The eighth annual meeting of this association will be held in Rochester, Sept. 16, headquarters being at Powers' Hotel. An interesting sign of the times is the announcement that this meeting will be specially devoted to matters electrical. A paper on "Electrical Traction" is promised. Various electrical companies will be fully represented. The Rochester Railway Company will extend its hospitalities to the visitors, and a large and important gathering is promised. A special train will leave, via the West Shore Railroad, Monday, Sept. 15, from the foot of Jay street, 5 P. M., and the meeting will very possibly include a session on Wednesday morning in addition to the regular proceedings on Tuesday.

PERSONALS.

Dr. A. F. Mason, of Boston, was in the city on business last week, and found time to call at our office.

Dr. Louis Duncan, of Johns Hopkins University, has just returned from his summer vacation on the coast of Maine.

Prof. Edward L. Nichols, of Cornell University, passed through this city last week on his way to Ithaca. He has just returned from a summer trip along the coast of Maine, and will spend this month remodeling and rearranging the rooms of the physical laboratory at Cornell, preparatory to the work of the coming year.

Mr. Morris W. Mead, superintendent of Pittsburgh's bureau of electricity, returned home from the East a few days ago. Mr. Mead had been in attendance at the National Electric light Convention, and during his absence visited New York to give directions with regard to the machinery for Pittsburgh's new fire alarm

office. This apparatus is being manufactured by the Gamewell Company, and will be complete in every detail.

Industrial and Trade Notes.

Messrs. Gill & Co., of the Washington Flint Glass Works, of Philadelphia, report their business with the electrical people as excellent.

"Business Never Was Better."—That is what Stanley G. Flagg, Jr., of Philadelphia, says, who manufactures malleable iron insulating joints, iron pipe fittings, etc.

The American Waterproof and Weatherproof Paint Company, 19-21 South Canal street, Chicago, is supplying a waterproof paint of value in certain branches of electrical work.

A Handy Tool.—The Central Electric Company, of Chicago, has placed in stock a number of Perry wire peelers. This handy little tool is well adapted to bellhangers' and incandescent wiring men's use.

The Central Electric Company, of Chicago, has just received a large stock of the new Stoddard porcelain cut-outs. This cut-out has come into great favor with electrical construction men, and the above company reports very large sales of it.

The Connecticut Motor Company, of Plantsville, Conn., having increased its capital stock intends to extend its facilities for manufacturing motors and generators, which are well liked wherever they are used. The amount of business done by this Company during August is reported to exceed any month so far this year.

Messrs. Rohrbacher & Hormann, of Philadelphia, are among the oldest and most extensive glass manufacturers in the country. They are making arc and incandescent electric light globes and shades in great variety and their business in this line is rapidly growing.

The Wainwright Manufacturing Company, of Boston, reports the sale of one 700 h. p. heater to the New Bedford Gas Light Company; one 600 h. p. heater to the Waltham American Watch Company, and one 400 h. p. heater to the Crown Rolling Mills, Minneapolis.

Successful Spark Arrester.—The Central Electric Company is very much pleased with the favor with which their new spark arrester is being received by the public. This device, as well as preventing sparks from falling from arc lamps, also prevents flies and other insects from getting into the globes.

The Sioux City Electric Supply Company, of Sioux City, Ia., reports the sale of over $3,000 worth of Hawkeye motors in its territory during the past month. Among the novel uses to which some of these motors will be applied is the pressing of old rags into bales in an establishment at Des Moines, Ia. One will also be used to cut corn for decorating the Sioux City Corn Palace.

The Standard Supply Company, of Boston, has secured the agency of Day's Kerite wire and other electrical specialties manufactured by this company. The managers will also push Hill's double-pole switches and converter boxes and the "H. G." key socket. A novelty in the way of a flexible bracket has been secured for Eastern territory that is likely to have a large sale.

Removal.—We note the removal of F. B. Aspinwall to 121 Liberty street, New York. His largely increasing business, and the need of better facilities make this removal necessary. Mr. Aspinwall reports large sales recently, especially of the Park double tube injector, as well as the Hoffman damper regulator, and Lyman & Warren exhaust heads. Of the latter, the company is now putting in two 16-inch heads at the plant of the Buffalo street railway.

Messrs. Pattison Bros., electrical engineers and contractors, at 135 and 137 Broadway, in this city, have just finished putting in order the lights and station of the Edison Electric Illuminating Company, of Lancaster, Pa. These gentlemen have also just completed the wiring of the factory of John Simmons & Co., in Leonard street, this city, for 250 incandescent lamps. They are also installing a 45-light arc plant in Sunbury, Pa., for Mr. P. B. Shaw.

A Good Insulator.—Judging from the popularity of the Cutter E. L. Insulator, the blackening of ceilings by arc light wires should be less frequently met with than heretofore. The reason is quite plain, as there seems to be no practical way of avoiding the blackening when the ordinary porcelain insulators are used. But as this unsightly effect decreases rapidly as the distance between the wires and the ceilings becomes greater, this insulator seems to have practically solved the difficulty.

J. Elliott Shaw & Co., 53 N. Seventh street, Philadelphia report much activity in their line of goods. Their works have been running constantly during the summer making up specialties for the fall trade. The railroad companies are recognizing the value of their double-armature bells, and they have lately shipped the Thomson-Houston Motor Company, of Boston, six of their large sizes. Their burglar alarm window and door springs have a large sale in their own city, showing that home talent is appreciated.

A Fine Catalogue.—We have just received an admirable catalogue of electric supplies from the Great Western Electric Supply Company, of Chicago. It purports to be only a sketch catalogue giving a general idea of the goods which this enterprising company can supply; but its size and general appearance would do credit to a much more elaborate title. The Great Western Company has made excellent headway during the short time it has been in existence, and every report that comes from Chicago is of an increase of business and extended facilities.

A Good Investment.—It is a fact well-known to steam users that large losses of steam and power are incurred by not thoroughly protecting the exposed surfaces of steam pipes and boilers. Experience has shown that a saving of 15 to 20 per cent. can be made in fuel by covering the pipes, boilers, breechings, domes, etc., with mineral wool covering, which is absolutely fireproof. The Chicago Fire Proof Covering Company, 89 Lake street, Chicago, prepares this in portable sections 3 feet long for pipes, and in blocks 8 × 18 inches for boilers, breechings, etc. It is light, durable and easily applied.

Mr. Russell Johnson manufactures, at the Cherry street molding and planing mill, 459-465 Cherry street, New York City, all kinds of moldings for electrical purposes, including those adapted to either the two or three wire system, double or single wires, and made in either hard or soft woods. Those who are accustomed to purchase moldings for electric wire realize the difficulty often met with in securing the goods promptly when made to order. Mr. Johnson's facilities for this work are so excellent that he is able to supply at very short notice any demands for this class of goods. He has at different times furnished moldings for some important Edison plant, both land and marine.

The Carr Metal Company, of Fall River, Mass., is receiving some excellent recommendations for its zincs. The Commercial Cable Company, of Boston, has been using the 5 × 7 crowfoots for eight and a half months; and although two of these working in series are worn nearly away, they still retain their full working force, and the battery does its regular work. Zinc pencils that were put into use on Leelanche batteries August 13, 1889, are still working satisfactorily. Another test of 1,950 cells made by the Long Distance Telephone Company, of New York, using 6 × 8 crowfoots, shows 12 months continual working and still in good order. This company is rapidly extending its business, and is pushed to fill its orders.

The Baxter Electric Motor Company, of Baltimore, Md., is now increasing its boiler capacity by the addition of another 100 h. p. boiler, purchased from John T. Coleman, of Baltimore, Md. This will be a great relief, as the present capacity of boilers has been very much overtaxed for the past two months, owing to the very rapid and constant increase in business. The growth of business of this company has so far exceeded its expectations that the managers are now thinking seriously about increasing their already extensive shop facilities, and contemplate erecting two large buildings some time during the coming year, believing that by the time these are up they will have enough business to fill them to their utmost capacity.

Removal.—The Field Engineering Company has moved into more commodious quarters at 15 Cortlandt street, in this city. The company now occupies the front rooms of the fourth floor, where good light is secured in the drafting and engineering departments. The company is at present completing some extensive electric railroad work in Newark, N. J., and has just secured the contract for laying the cement-lined pipes of the National Conduit system of the Buffalo Electric Street Railroad. These pipes are to be used for carrying feeders underground. Mr. C. J. Field, the engineer of the company, gives personal attention to all the construction, thus insuring first-class work. The company controls many new and valuable patents upon electric railroad construction.

A Fine Stock of Instruments.—The assortment of testing instruments kept in stock by the Great Western Electric Supply Company is steadily growing. During the past week a nice lot of Wheatstone bridge sets mounted in compact cases were added. These have sensitive galvanometers with arrestment for the needles, and are carefully calibrated. Together with the detector galvanometers, portable magnetos and speed indicators in stock and the voltmeters and ammeters under way, these form a collection of such apparatus as every station manager would feel proud of. It certainly pays well to know in just what shape the dynamos and circuits are, and the handling of such instruments as the above firm is showing will meet with the desired approval of all who are interested in electric work.

Increased Business.—Owing to the largely increasing business of the Wainwright Manufacturing Company it has been obliged to move its New York office to 121 Liberty street, where with the increased facilities that it will have to show its goods, the company will be able to keep up with its rapidly increasing sales in this city and elsewhere. We learn from the New York manager, Mr. F. B. Aspinwall, that the demand for the goods of this company was never so large, and especially for its improved feed water heaters, of both the high pressure and the special compound engine type. The company has furnished a large number recently to electric light plants for increased power, and also to new stations. It is the intention of the company to keep as far as practicable a stock of its manufactures at its New York house.

The Consolidated Electric Storage Company, of 120 Broadway, this city, is doing a good business in the installation of Julien storage batteries for lighting purposes. A good idea of the construction and operation of this company's batteries was furnished at the recent Cape May convention by the fine display of a small number of batteries. The batteries exhibited were 12 in number, and furnished a current for lighting three 24-volt incandescent lamps and for driving a small electric motor adapted to ventilating purposes. The display attracted considerable attention, and gave many of the electric light men and their friends at the convention a good idea of the advantages possessed by the Julien batteries for the operation of either electric lights or motors. The cells were operated for the three days of the convention without recharging. The Consolidated Company was well represented at the Cape May Convention by Mr. Wm. Bracken, Mr. P. G. Salom and F. H. Deacon.

Messrs. Conover & Co., No. 95 Liberty Street, New York City, report increasing demand for their independent steam engine condensers and among recent sales are the following: Four belt power condensers of 350 h. p. capacity each to the Newark Electric Light and Power Company; one of 150 h. p. capacity to the Thomson-Houston Electric Company, for the Passaic Electric Light Heat and Power Company, Passaic, N. J.; one of 150 h. p. capacity to the Thomson Houston Company, of Boston, Mass.; two independent steam condensers to the Field Engineering Company, of New York City, for the Buffalo Street Railway, Buffalo, N. Y. These two machines are of 800 h. p. capacity each and are driven by a special compound condensing engine attached directly to the air pump. The engine is fitted with a Corliss cut-off and dash pot complete on the high pressure side, and will get about 12 expansions out of the steam. These condensers are claimed by the builders to be the most economical and efficient now offered to the public.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

An Ingenious Motor.—(A. A. M.) The form of motor described in your sketch is certainly very creditably ingenious, although the plan you propose is not altogether new. There are forms for small motors much more desirable, however, because mechanically much simpler. The principal advantage of such an arrangement as yours, as you will see by reference to Mr. Wadsworth's article in this issue, is low speed. As a general rule, the simpler you can make a small motor the better results you will get out of it. If you complete the machine you describe, we shall be glad to hear how it succeeds.—ED. E. W.

A Light for Projection.—Having a good stereopticon, and gas for calcium light not being available, I thought to avail myself of the alternating current by which my house is lighted. In Hopkins' "Experimental Science" there is described an electric lamp employing a Jablockoff candle, which, if applicable, would, I think, serve my purpose. Can such a lamp be operated on a 52-volt constant potential circuit? Is the use of such a lamp feasible, and how should the current be regulated—by a fixed or movable resistance? S. L. W.

You could operate a Jablockoff candle on your circuit, but it probably would not be entirely satisfactory. A better plan would be to use a powerful incandescent lamp. Incandescent lamps are made specially for projection, and there would, of course, operate as well on the alternating current as on any other. A 100 c. p. incandescent lamp will give beautiful results for projection, as it is perfectly steady and requires no adjustment whatever. Correspondence with some of the lamp companies will probably secure what you desire.

Storage Batteries for Arc Lights.—Can you tell me how to make a storage battery for lighting three 50-volt, 8½ ampère arc lights? I am running a plant of 36 arc lights, and we only use regularly 23 of them. We run 10 hours a day, and I would like to charge the storage battery while we are running so as to light these three lamps at all times. A. McK.

We would not advise you to attempt to make a storage battery, as the home made affairs are not likely to be of satisfactory efficiency or durability. To light your three lamps, placed in series, will require about 70 cells of battery which you can charge from your lighting circuit readily enough. The expense of installation, however, and the amount of care required make it rather doubtful policy unless there is considerable need for the lamps during off hours. We would advise you, if you are going to try it, to get and read some books on accumulators and their use, as the amount of detail is too great to be satisfactorily given in these columns. Mr. Pumpelly's papers on the subject, published in some recent numbers of THE ELECTRICAL WORLD, will perhaps give you all the information you need.

A Few Questions.—(1) Is there any strain on an armature except that due to centrifugal force? 2. What is the resistance of an Edison 110-volt incandescent lamp? 3. Is there a lightning arrester manufactured that is an absolute protection against lightning in a railway power plant? 4. Is there any automatic arrangement that will afford protection for railway generators against the heavy grounds that too often occur? O. B. S.

(1) Yes; there is a heavy strain on the wires due to electro-dynamic attraction. The pull of the field magnets in a motor on the armature wires is decidedly severe, and special care has to be exercised in arranging to avoid loosening or displacement. In a dynamo this same tangential strain occurs, although it is practically less serious, because more uniform. In designing motors the starting point is frequently this very tangential strain—the torque or twist exercised by the magnetic field on the armature wires. (2) The resistance of an 110-volt lamp varies very widely both in different lamps and in the same lamp at different degrees of incandescence. An Edison lamp of which we have the exact figures had a resistance of 245 ohms when heated to incandescence; cold resistance would probably have been about 400 ohms. This is a high figure for a 16 c. p. lamp of the given voltage. Other styles vary between this and perhaps 150 ohms hot. (3) We do not know of any such lightning arrester at present on the market. A railway generator seems to be specially thin-skinned as regards lightning. Some lightning arresters may occasionally ward off injury, but it requires so little lightning to punch the insulation of a high tension armature that complete protection is exceedingly difficult. (4) There are several automatic cut-outs intended to save armatures from the effects of short circuits. Most of them are very simple magnetic affairs arranged to cut out the armature or the entire machine when the current rises above a certain point.

Business Notice.

Three Links.—Travelers on business or bent on pleasure in variably visit one of the great cities of the West, if their journey is at all prolonged. Nowhere else can be seen such centres of enterprise and American vim as in Chicago or Kansas City, and few invite lovers of elegance and beauty like St. Louis. In going farther into the "Great West," there are various routes the tourist may select from, but supposing the start is made from Chicago, the great starting point of western travel, no line can be found more desirable than the Chicago and Alton, the great "Three Link" route, and its unsurpassed connections. Elegant cars, courteous train men, a first-class track, and every convenience that modern railroading employs is here found for safety and comfort. The country traversed is unexcelled for beauty of scenery—the veritable garden of the continent. Be sure and secure tickets of the Chicago & Alton if you would have a pleasant journey.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

U. S. PATENTS ISSUED SEPTEMBER 2, 1890.

435,421. Battery Compound; Ernest M. Gardner Hewett, of Newton, Mass., Assignor, by direct and mesne assignments, to the Safety Electric Light Company, of Maine. Application filed June 29, 1889. Renewed Feb. 3, 1890. A battery compound composed of a battery trioxide of chromium and muriate of ammonia.

435,124. Electric Switch; Charles W. Huntington, of Baltimore, Md. Application filed January 24, 1890. The invention consists of a base of insulating material, in the face of which a circular groove or channel is formed, the bottom of the channel being formed of four inclined planes, the opposite ends of each of which are respectively in two parallel planes. Two of these metallic surfaces are armed with metallic plates and the other two are left bare. A centrally pivoted circuit controlling arm is provided with contact brushes at its opposite ends, which, when the arm is turned in one direction drag over the inclined surface and make or break the electric circuit. A spring is arranged in connection with the circuit controlling arcs to hold the brushes in contact with the inclined surface.

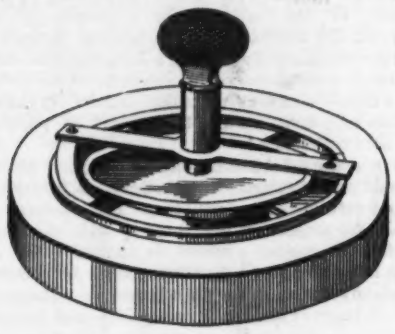
435,440. Automatic Electric Annunciator; John W Luthe and Alfred E. Jeavous, of Cleveland, Ohio; said Jeavous Assignor of one half to said Lushe. Application filed January 23, 1890. An electric annunciator comprising a series of primary helices and a series of opposing secondary helices, with pointers adapted to vibrate between the cores of opposing helices, primary and secondary, the primary helices being connected, respectively, with the different call-buttons and connected in common with the battery wire, the latter including in its circuit the secondary helices and call bell branch wires leading from the battery to the different call bells.

435,447. Electric Conductor for Street Railways; Luther M. Perkins, of St. Louis, Mo. Application filed October 17, 1889. In an electric railway, a trolley track having a continuous and yielding bed timber for the contact rail, a series of sections of contact rail mounted thereon, each section provided with a projecting contact post, and an insulated continuous electric conductor having the insulation removed at intervals, whereby the contact post can be brought in electrical contact with the conductor when the trolley track is depressed.

435,471. Electric Railway Closed Circuit System; Malone Wheless, of Nashville, Tenn., Assignor by direct mesne assignments to the Wheless Electric Railway Company, of Alexandria, Va. Application filed Oct. 23, 1889. In an electric railway conduit system, the combination of a power line, a motor line on a car normally out of electrical connection with the power line and a local circuit, part of which, including the source of electricity, is on the car, part of the electrical fitting of the local circuit being in the power and motor lines and conversely, whereby when the local circuit is closed the motor line is electrically connected to the power line and the local is immediately broken.

435,482. Block Signal System; Mahlon S. Conly, of Chicago, Ill., Assignor to the United States Electric Railway Signal Company, of New York, N. Y. Application filed Dec. 7, 1889. In a block signaling system, the combitation, with a series of signals, a pair of opposing electro-magnets for operating each signal, and a local circuit therefor, of a secondary circuit connecting each pair of signals and a polarized relay for each signal, included in said secondary circuit, for shunting the primary current of the local circuit alternately through said electro magnets.

434,486. Conduit for Electric Railways; William R. Elliott, of Kansas City, Mo. Application filed Jan. 18, 1890. An electric conduit consisting of a casing having flexible pieces in one side, a conductor within said casing and metallic bars passing through and held in place by said flexible pieces, the inner ends



No. 435,424.—ELECTRIC SWITCH.

of the bars being normally below and out of contact with the conductor.

435,487. Electric Conduit; William R. Elliott, of Kansas City, Mo. Application filed March 20, 1890. In an electric conduit a two-part waterproof tube, the upper part of which is removable, insulating plates therein provided with open top notches, within which the conductor rests and plates secured across the upper ends of said notches.

435,490. Automatic Electric Switch; Theodore M. Foote, of Boston, Mass. Application filed April 25, 1888. Renewed July 23, 1890. The combination of an electric conducting revolving drum and an electric conducting segment upon the same shaft, but insulated from each other with contact springs and with an arm adapted to be moved by centrifugal force when a given rate of speed has been reached toward the periphery of the drum, in combination with the driving shaft of a dynamo, whereby an electric circuit is automatically closed at such speed.

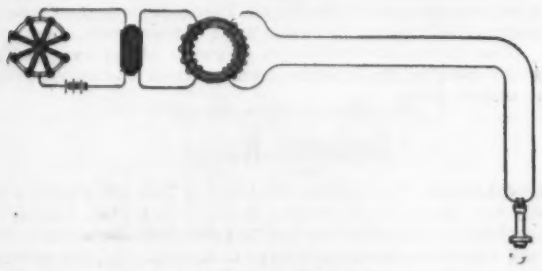
435,503. Commutator; Charles A. Lieb, of New York, N. Y. Application filed April 30, 1890. A commutator comprising, essentially, a series of bars having undercut parts or ledges on their inner surfaces and the ledges on their ends and insulating material between the bars and about the said undercut parts and ledges.

435,504. Commutator and Process of Making the Same. Charles A. Lieb, of New York, N. Y. Application filed May 6, 1890. The combination, in a commutator, of a series of bars having perforated dovetailed projecting parts on their inner sides and insulating material about the same and in the perforations

435,505. Suspender or Support for Overhead Wires; Charles A. Lieb, of New York, N. Y. Application filed June 13, 1890. A non-conducting suspender for electric wires, &c., comprising a non-conducting part provided with an enlarged portion, and a cap formed of a single piece of metal which conforms to the shape of the enlarged portion of the non-conductor and provided with means whereby it may be attached to a support.

435,516. Electric Signaling Apparatus for Preventing Collisions between Railway Trains; Theodore Perls, of Wurzburg, Germany, Assignor of one-half to Martin Perls, of London, England. Application filed January 31, 1890. Patented in France, February 4, 1889; in Belgium, Feb. 4, 1889; in Germany, February 5, 1889; in Italy, March 31, 1889; and in Austria-Hungary, June 3, 1889. The alternate short and long sections of interrupted conductors, in combination with the corresponding diagonal conductors and a continuous conductor.

435,518, Apparatus for Preventing Incrustation in Boilers; John Pollock, of Belfast, Ireland. Application filed June 3, 1890. Patented in England December 19, 1888. In an apparatus for purifying wated in steam boilers, a copper strip or rod



No. 435,438.—TELEPHONY.

and a zinc ball or cylinder arranged to move in contact with each other.

(1) 435,525. (2) 435,526. (3) 435,527. Regulator for Dynamo-Electric Machines; Charles E. Scribner, of Chicago, Ill., Assignor to the Western Electric Company, of same place. Applications filed (1) April 28, 1885; (2) March 8, 1886; (3) Nov. 19, 1887. The combination in a regulator for dynamo-electric machines, with a constantly driven screw and racing nut placed thereon, of mechanism for revolving the racing-nut faster than the screw, and a stop mechanism for disengaging the revolving mechanism from the nut at a certain point, whereby the longitudinal movement of the screw is limited.

435,536. Electric Conduit; Herbert N. Curtis, of New York, N. Y., Application filed March 31, 1890. An electric conduit provided with a longitudinal slit in its top and an enclosed conductor, combined with a flexible cover for the slit, comprising a conducting portion that makes contact with an external conductor extended into the slit and is pressed thereby into contact with the enclosed conductor.

435,545. Automatic Regulation of Electric Circuits; George B. Prescott, Jr., of Newark, N. J., Assignor to the Accumulator Company, of New Jersey. Application filed April 29, 1890. The combination of an Electrical generator, a circuit containing translating devices supplied with electricity thereby, a secondary battery connected to said battery, a sectional artificial resistance located in circuit between the generator and translating devices, a switch for gradually introducing and withdrawing said resistance and electric motor for operating said switch, two separate electro magnets connected with the circuit to be regulated and responsive to respectively opposite variations in current therein, a local circuit containing the coils of the motor, a pole changing switch in said local circuit for reversing the connection of the motor coils, and a local circuit for operating said pole changer, controlled by said two electro magnets.

435,550. Electrical Measuring Instrument; George Washington Walker, of New York, N. Y. Assignor to the Walker Electric Co., of same place. Application filed May 15, 1890. The combination of a curved solenoid magnet having its coil tapering or of varying diameter, a curved or circular pivoted core, and a needle or indicator.

435,558. Railway Signal; William F. Z. Desant, of New York, N. Y. Assignor to the Desant Electric Company, of Columbus, Ohio. Application filed Oct. 31, 1889. The invention relates to improvements in railway signals of that type known in the art as "block signals," and in which the apparatus is regulated in its action, or controlled by electricity.

435,559. Upward Pressure Contact for Electric Railways; John A. Duggan, of Quincy, Mass., Assignor to the Burnham & Duggan Railway Appliance Company. Application filed Dec. 13, 1888. In a vehicle to be propelled by electricity, the combination of a suitable electric motor, means for maintaining continuous contact with an overhead cable or wire conveying an electric current, consisting of two trolleys connected by an equalizing bar, and acting by upward pressure contact on the cable or wire, and means for connecting said trolleys with the motor.

435,578. Switch for Incandescent Lamp Sockets; Waldo C. Bryant, of Bridgeport, Conn. Application filed July 14, 1890. A switch for incandescent lamp sockets, consisting of binding screws, a contact spring connected to one of the binding screws, a shaft having a contact bar and a four-sided block with which the other binding screw is connected, and an independent spring bearing against the block and acting to hold the contact bar in either the open or closed position.

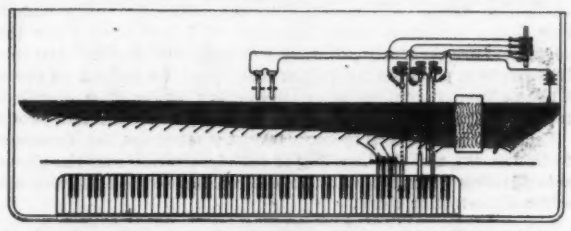
435,629. Apparatus for Covering Electric Wires; Alfred G. Holcombe, of Long Island City, Assignor of one-half to Charles L. Browne, of New York, N. Y. Application filed March 17, 1890. The object of the invention is to produce an electrical conductor having a covering of non-carbonizable, indestructible insulating material, and an exterior hermetically closed tubular sheath of metal.

435,639. Electric Motor; Harry H. Blades, of Detroit, Mich., Assignor to the Detroit Motor Co., of same place. Application filed Sept. 25, 1888. The invention has for its object the construction of a motor with a manipulating switch mechanism connected directly therewith, said mechanism adapted to govern the admission of the current to the motor.

435,640. Means for Supporting Storage Batteries on Railway Cars; Harry H. Blades, of Detroit, Mich. Application filed Jan. 10, 1890. The combination, with a railway car, of an independent frame for supporting secondary batteries, said frame extending substantially the length of the car body and attached thereto and independent of the track.

435,641. Electric Railway Car; Harry H. Blades, of Detroit, Mich. Application filed January 10, 1890. In a railway car, the combination, with an electric motor for operating the car, clutch mechanism for throwing the motor into or out of gear with the car axle and brake mechanism for operating the car wheel brakes, of a rod for simultaneously operating said brake and clutch mechanism.

435,642. Electric Railway Car; Mark W. Dewey, of Syracuse, N. Y., assignor to the Dewey Corporation, of same place. Application filed March 26, 1890. In an electric railway, a working conductor arranged along the railway, a traveling vehicle, an electric motor to propel said vehicle, a current collector extending from the vehicle to the conductor, an electric connection between said motor and collector, one or more signal balls, and a



No. 435,679.—PRODUCING MUSICAL SOUNDS BY ELECTRICITY.

plurality of circuit makers and breakers in said electric connection, and a shunt including a resistance around signal bell or bells and circuit makers and breakers.

435,643. Method of Electric Welding; Mark W. Dewey of Syracuse, N. Y., assignor to the Dewey Corporation, of same place. Application filed June 12, 1890. The method of metal working, consisting of electrically heating and softening the junction of pieces of metal traversing it with a heavy electric current and then applying a force to twist the metal at the junction.

435,644. Method of Electric Welding; Mark W. Dewey, of Syracuse, N. Y., Assignor to the Dewey Corporation of same place. Application filed June 14, 1890. The process of welding metals electrically, consisting in making contact with both pieces to be united and passing a current of greater strength through one piece than the other.

435,660. Manufacture of Filamens for Incandescent Lamps; Vincent M. Hobby, of New York, N. Y. Application filed October 26, 1889. The composition or paste consisting of carbon, sugar and mucilage of one ounce each.

435,662. Electric Railway; Rudolph M. Hunter, of Philadelphia, Pa., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed February 23, 1887. Divided and this application filed October 18, 1889. In an electric railway a slotted conduit of considerable depth, a removable metallic cross-plate adapted to be secured across the conduit near the top, connecting the side walls thereof, upwardly extending insulators carried by said cross plates and a working conductor supported upon said insulators and electrically independent of the metallic cross-plate.

435,668. Electric Cigar Lighter; John Roberts, of Pittsburgh, Pa., Assignor of two-thirds to Homer H. Redpath and Irvin Redpath, of same place. Application filed Feb. 3, 1890. An electrical cigar lighter, consisting of a base having a reservoir formed integral therewith and vertical tubes secured to the base and lighters inserted in the tubes, and having a handle of insulated material and a metallic brush, a suitable figure erected on the base, but insulated therefrom, and having an electrical contact and an open circuit having one of its wires connected through the base to the figure, said circuit also including a source of electrical energy and having its wires connected with base and lighters.

436,679. Method of and Apparatus for Producing Musical Sounds by Electricity; George Breed, of the United States Navy. Application filed Jan. 31, 1890. The herein described method of producing sound electrically by passing a maintained non-continuous current through a wire stretched in a magnetic field.

435,687. Means for Charging and Using Secondary Batteries; Thos. A. Edison, of Menlo Park, N. J., Assignor to the Edison Electric Light Company, of New York, N. Y. Application filed Sept. 3, 1881. Patented in England Oct. 18, 1881, and in France Dec. 17, 1881. The combination, with secondary batteries and translating devices supplied thereby, of a variable auxiliary source of electricity for re-enforcing said batteries as their electromotive force decreases.

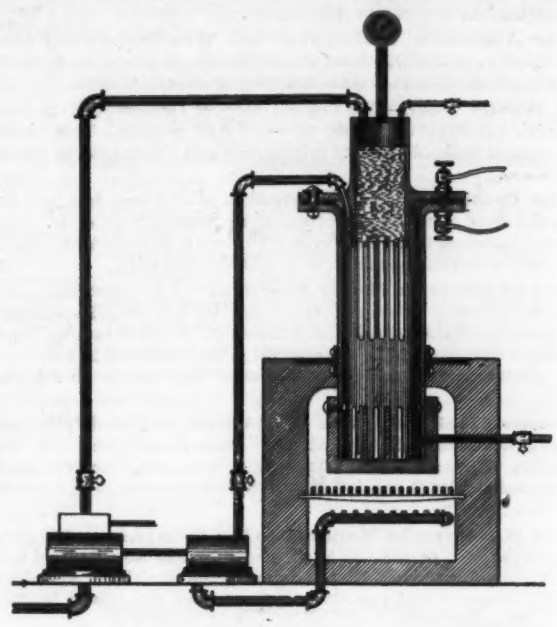
435,688. Process of and Apparatus for Generating Electricity; Thomas A. Edison, of Menlo Park, N. J. Application filed Sept. 19, 1883. The art of generating electricity, which consists in producing dry chemical reaction in a closed chamber and charging or acting upon two terminals of the electric circuit, respectively, by the products of such reaction.

435,689. Telegraphy; Thomas A. Edison, of Llewellyn Park, N. J. Application filed Feb. 19, 1886. In telegraphs, the combination, with a line grounded at its ends, of two or more Morse induction sets, each composed of a diaphragm receiver and an induction transmitter located directly in said line and one or more intermediate ground connections dividing such line into independent non-interfering induction circuits.

435,690. Method of Making Armatures for Dynamo Electric Machines; Thomas A. Edison, of Llewellyn Park, N. J. Application filed Sept. 15, 1888. The method of making armature cores, which consists in simultaneously winding several wires side by side into an annular coil, said wires being sufficient in numbers to constitute one layer of the core, whereby an entire layer is made by a single winding, and continuing the winding as many times as there are to be layers of wire within the core.

435,695. Electric Current Insulator; Albert B. Herrick, of New York, N. Y., Assignor to the Bergmann Co., of same place. Application filed March 13, 1890. The combination, in an electric current indicator, of a coil, a pivoted ring movable therein, and a plate armature carried by the ring.

435,700. Device for Controlling the Current of Electric Generators; H. Ward Leonard, of Chicago, Ill. Application filed March 13, 1889. The combination, with a source of electricity, a circuit leading therefrom, and translating devices,



No. 435,688.—GENERATION OF ELECTRICITY.

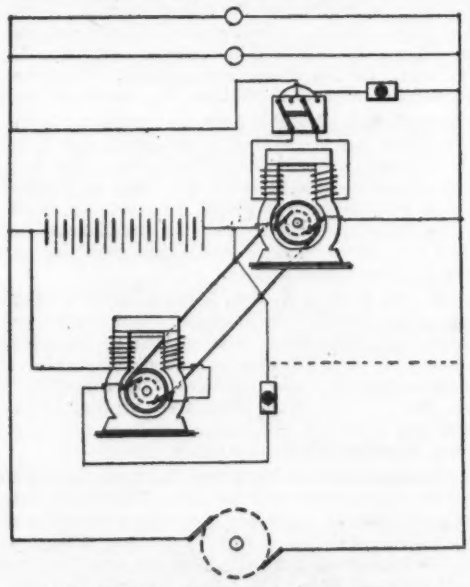
of a branch containing a secondary battery and an auxiliary generator, and an electric motor, connected with secondary battery and operatively connected to the auxiliary generator.

435,744. Electric Motor; Henry Groswith, of Philadelphia, Pa., Assignor by direct and mesne assignments of three-fourths to Charles W. Kennedy, of same place. Application filed Jan. 7, 1890. In an electric motor or generator, the combination of a field magnet having inner and outer cores, respectively, wound with coils connected in opposite directions, an armature having two sets of windings, separate commutators and brushes therefor.

435,801. Railway Signal; Michele Cortese, of Philadelphia, Pa., Application filed May 7, 1890. The invention relates to that class of railway signals which are intended to prevent the collision of trains running in opposite directions upon the same line of track.

435,870. Suspending Device for Overhead Electric Conductors; Elihu Thomson, of Lynn, Mass., Application filed June 20, 1890. The combination, with the span wire of an electric railway line structure and a supplemental wire connected thereto and forming a depending loop, of the line conductor suspended from the loop.

(1) 435,893. (2) 435,894. Electrical Signaling Apparatus; Adin A. Hatch, of Kansas City, Mo., Assignor to Benjamin F. Jones, Edward L. Martin and Alfred W. Jones, all of same place. Application filed (1) Nov. 20, 1889. (2) Jan. 6, 1890. In an electric signal system, a signal receiving relay located normally in the main line and having local circuit connections with a local signaling instrument, in combination with an individual



No. 435,700.—CURRENT CONTROLLER.

automatic cut-out device located in a local circuit controlled by the same relay, and responsive only to a prearranged signal.

435,896. Electrical Indicator; John W. Howell, of Newark, Assignor to the Edison Lamp Company, of Harrison, N. J. Application filed March 30, 1889. In an electrical indicator, in which the potential tested is opposed by a battery of standard potential, the combination, with means for connecting the indicator to the circuit to be tested, of the galvanometer and key, two battery cells, forming a part of said indicator, and connections whereby one or both of the said cells may be placed in the circuit.

435,897. Electrical Controlling and Operating Apparatus; Edward H. Johnson, of New York, N. Y., Assignor to the Interior Conduit and Insulation Company, of same place. Application filed Oct. 19, 1887. In an electrically operated controlling or operating apparatus, the combination, with a circuit controler, of a magnet maintaining the circuit after once established by the circuit controller, an electric motor in circuit with the magnet, moving parts worked by said motor, and a circuit breaker operated by such moving parts and breaking the circuit through the magnet.

435,899. Electric Current Regulator; Edward H. Johnson, of New York, N. Y. Application filed October 19, 1887. In an electric current regulator, the combination, with a pressure magnet, of an electric motor controlled thereby, a current varying device operated by said motor, and a clutch magnet also controlled by the pressure magnet and acting to connect and disconnect the motor and the current varying device.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1836—can be had for 25 cents. Give the date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.

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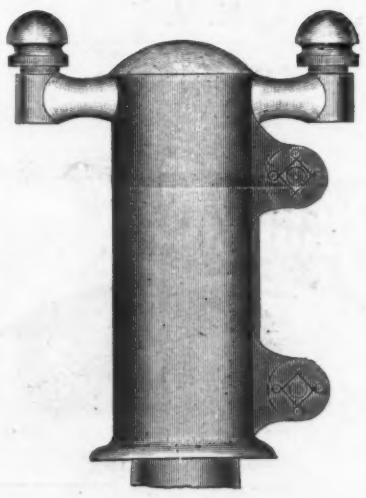

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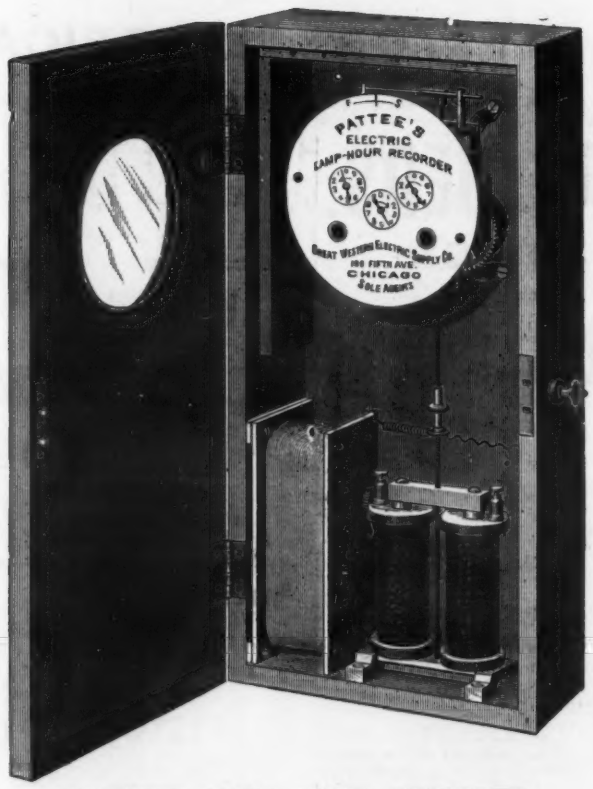

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(Patent allowed).

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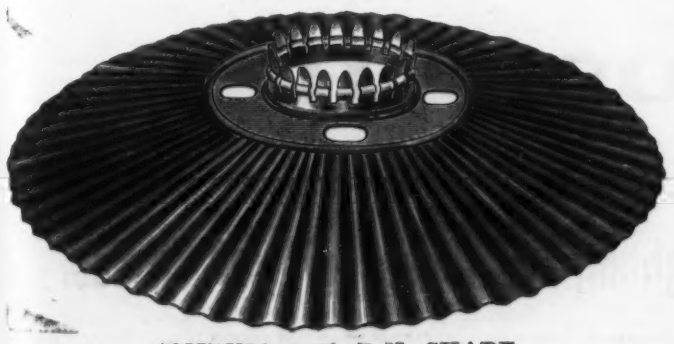
CIRCULAR 513.



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PAISTE

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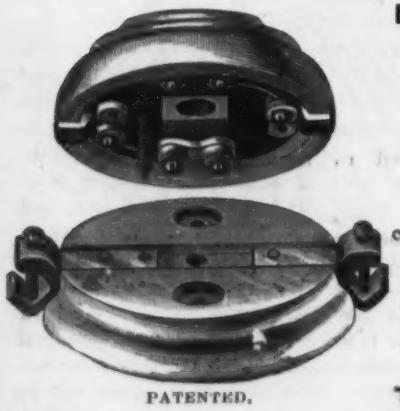

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